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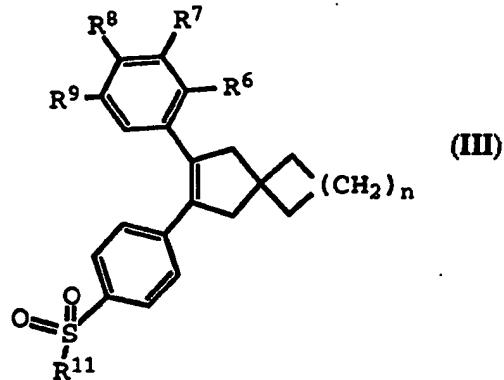
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(54) Title: SUBSTITUTED SPIRO COMPOUNDS FOR THE TREATMENT OF INFLAMMATION

(57) Abstract

A class of substituted spiro compounds is described for use in treating inflammation and inflammation-related disorders. Compounds of particular interest are defined by formula (III), wherein n is a number selected from 0, 1 and 2; wherein R⁶ is selected from hydrido and halo; wherein R⁷ is selected from hydrido and halo; wherein R⁸ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower haloalkyl, lower haloalkoxy, and hydroxyl; wherein R⁹ is selected from hydrido, halo, and lower alkyl; or wherein R⁸ and R⁹ together form methylenedioxy; and wherein R¹¹ is selected from lower alkyl and amino; or a pharmaceutically-acceptable salt thereof.



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SUBSTITUTED SPIRO COMPOUNDS FOR THE
TREATMENT OF INFLAMMATION

FIELD OF THE INVENTION

5 This invention is in the field of antiinflammatory pharmaceutical agents and specifically relates to compounds, compositions and methods for treating inflammation and inflammation-associated disorders, such as arthritis.

10

BACKGROUND OF THE INVENTION

Prostaglandins play a major role in the inflammation process and the inhibition of prostaglandin production, especially production of PGG₂, PGH₂ and PGE₂, has been a common target of antiinflammatory drug discovery. However, common non-steroidal antiinflammatory drugs (NSAIDs) that are active in reducing the prostaglandin-induced pain and swelling associated with the inflammation process are also active in affecting other prostaglandin-regulated processes not associated with the inflammation process. Thus, use of high doses of most common NSAIDs can produce severe side effects, including life threatening ulcers, that limit their therapeutic potential. An alternative to NSAIDs is the use of corticosteroids, which have even more drastic side effects, especially when long term therapy is involved.

30

Previous NSAIDs have been found to prevent the production of prostaglandins by inhibiting enzymes in the human arachidonic acid/prostaglandin pathway, including the enzyme cyclooxygenase (COX). The recent discovery of an inducible enzyme associated with inflammation (named "cyclooxygenase-2 (COX-2)" or "prostaglandin G/H synthase II") provides a viable target of inhibition which more effectively reduces

inflammation and produces fewer and less drastic side effects.

The substituted spiro compounds disclosed
5 herein preferably selectively inhibit cyclooxygenase-2 over cyclooxygenase-1 and relieve the effects of inflammation. These compounds, in addition, do not display substantial inhibition of cyclooxygenase-1 and produce a reduced amount of side effects.

10

Diarylcycloalkenes have been made and used for a variety of utilities. For example, Offenlegungsschrift 4,212,628, published Oct. 21, 1993, describes 1,2-bis(4-alkylphenyl)cyclohex-1-ene compounds as having anti-tumor activity. 2,3-Bis-(4-hydroxyphenyl)-2-cyclopenten-1-one has been identified from the knot resin powder of *Arcaucaria angustifolia* [H. Ohashi, et al., *Phytochemistry*, 31, 1371-73 (1992)].

20

Substituted 1,2-diphenylcyclopentenes have been synthesized for use in studies of their rotational behavior, and specifically, 1-(2,4-dimethylphenyl)-2-phenylcyclopentene [D. Y. Curtin, et al., *J. Org. Chem.*, 36, 565-72 (1971)]. 1,2-Di-(2'-methoxyphenyl)- Δ^1 -cyclopentene has been identified as an impurity in the synthesis of cannabinoids [O.P. Malik, et al., *Ind. J. Chem.*, 14B, 975-78 (1976)].

1-(Substitutedphenyl)-2-phenylcyclopentenes
30 have been synthesized to study their photochemical reactions into phenanthrene derivatives. Compounds with meta substituents, such as 1-(3-chlorophenyl)-2-phenylcyclopentene, are described in Somers, et al., *J. Photochem. Photobiol.*, 48A, 353-74 (1989). Para substituents, including specifically 1-(4-fluorophenyl)-2-phenylcyclopentene, are described in Laarhoven, *Pure & Appl. Chem.*, 56, 1225-40 (1984).

U.S. Patent No. 3,214,470 to Grogan describes aminospiroalkanes as having anesthetic properties.

The synthesis of 7,8-diphenyl-1,4-dioxaspiro[4.4]non-7-ene is described as an intermediate for forming 1,5-diphenylbicyclo[3.1.0]hexan-3-ol [E. J. Corey, et al., J. Amer. Chem. Soc., 85, 1788-1792 (1963)]. U.S. Patent No. 3,728,404 to Kubicek describes a method to make spiro compounds, and specifically 1,1-dichloro-2,2,5-triphenylspiro[2.4]hept-5-ene.

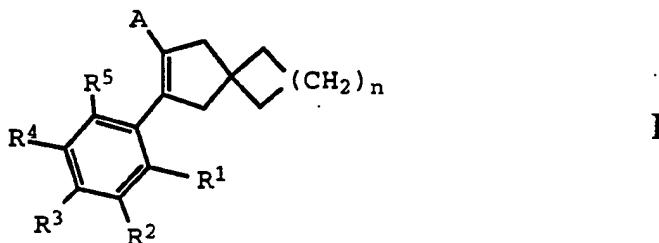
The invention's spiro compounds are found to show usefulness in vivo as antiinflammatory agents with minimal side effects.

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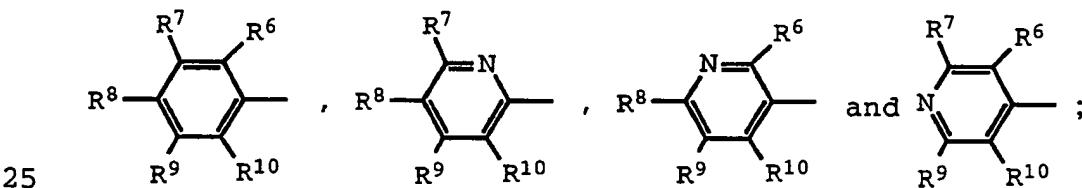
DESCRIPTION OF THE INVENTION

A class of substituted spiro compounds useful in treating inflammation-related disorders is defined by Formula I:

20



wherein A is selected from



wherein each of R¹ through R¹⁰, if present, is independently selected from hydrido, halo, alkyl, alkoxy, alkylthio, cyano, haloalkyl, haloalkoxy, hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto,

alkylamino, alkylsulfonyl, haloalkylsulfonyl and aminosulfonyl; and wherein n is a number selected from 0, 1, 2 and 3; or a pharmaceutically-acceptable salt thereof.

5

Compounds of Formula I would be useful for, but not limited to, the treatment of inflammation in a subject, and for treatment of other inflammation-associated disorders, such as, 10 as an analgesic in the treatment of pain and headaches, or as an antipyretic for the treatment of fever. For example, compounds of Formula I would be useful to treat arthritis, including but not limited to rheumatoid arthritis, 15 spondyloarthropathies, gouty arthritis, osteoarthritis, systemic lupus erythematosus and juvenile arthritis. Such compounds of Formula I would be useful in the treatment of asthma, bronchitis, menstrual cramps, tendinitis, bursitis, 20 and skin related conditions such as psoriasis, eczema, burns and dermatitis. Compounds of Formula I also would be useful to treat gastrointestinal conditions such as inflammatory bowel disease, Crohn's disease, gastritis, irritable bowel 25 syndrome and ulcerative colitis and for the prevention of colorectal cancer. Compounds of Formula I would be useful in treating inflammation in such diseases as vascular diseases, migraine headaches, periarteritis nodosa, thyroiditis, 30 aplastic anemia, Hodgkin's disease, sclerodoma, rheumatic fever, type I diabetes, myasthenia gravis, sarcoidosis, nephrotic syndrome, Behcet's syndrome, polymyositis, gingivitis, hypersensitivity, conjunctivitis, swelling 35 occurring after injury, myocardial ischemia, and the like. The compounds are useful as anti-inflammatory agents, such as for the treatment of

arthritis, with the additional benefit of having significantly less harmful side effects.

The present invention also includes compounds
5 which selectively inhibit cyclooxygenase-2 over cyclooxygenase-1 and do not significantly inhibit one or more other arachidonic pathway steps, such as thromboxane B₂ (TXB₂) production.

10 The present compounds may also be used in co-therapies, partially or completely, in place of other conventional antiinflammatories, such as together with steroids, NSAIDs, 5-lipoxygenase inhibitors, LTB₄ inhibitors and LTA₄ hydrolase
15 inhibitors.

More preferably, the compounds also have a selectivity ratio of cyclooxygenase-2 inhibition over cyclooxygenase-1 inhibition of at least 50, and
20 preferably of at least 100. Even more preferably, the compounds have a cyclooxygenase-1 IC₅₀ of greater than about 0.5 μM, and more preferably of greater than 5 μM. Such preferred selectivity may indicate an ability to reduce the incidence of common NSAID-induced side
25 effects, such as ulcers.

A preferred class of compounds consists of those compounds of Formula I wherein, if present, each of R¹, R², R⁴ through R⁷, R⁹ and R¹⁰ is independently
30 selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and mercapto; and wherein R³ is selected from lower alkylsulfonyl, lower haloalkylsulfonyl and
35 aminosulfonyl, and R⁸, if present, is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy,

lower hydroxyalkyl, lower alkoxyalkyl, lower alkylamino, hydroxyl and mercapto; or wherein further R⁸ and R⁹, if present, together form methylenedioxy; or wherein further, R³ is selected from hydrido, halo,

5 lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl, lower alkoxyalkyl, lower alkylamino, hydroxyl and mercapto, and R⁸ is selected from lower alkylsulfonyl, lower haloalkylsulfonyl and aminosulfonyl; or wherein

10 further R³ and R⁴, if present, together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

A class of compounds of particular interest

15 consists of those compounds of Formula I wherein, if present, each of R¹, R², R⁴ through R⁷, R⁹ and R¹⁰ is independently selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy,

20 hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl,

25 difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, trifluoromethoxy, hydroxymethyl, methoxymethyl and ethoxymethyl; and wherein R³ is selected from methylsulfonyl, fluoromethylsulfonyl, difluoromethylsulfonyl, trifluoromethylsulfonyl and

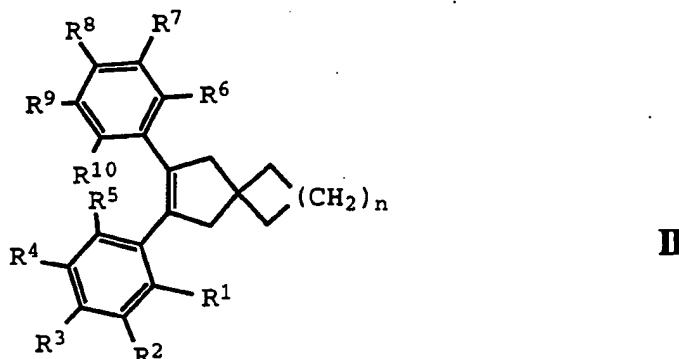
30 aminosulfonyl, and R⁸, if present, is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl,

35 difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl,

dichlorofluoromethyl, difluoroethyl, difluoropropyl,
dichloroethyl, dichloropropyl, methylamino, N,N-
dimethylamino, trifluoromethoxy, hydroxymethyl,
methoxymethyl and ethoxymethyl; or wherein further R⁸
5 and R⁹, if present, together form methylenedioxy; or
wherein further R³ is selected from hydrido, fluoro,
chloro, bromo, iodo, methyl, ethyl, n-propyl,
isopropyl, butyl, tert-butyl, isobutyl, methoxy,
ethoxy, propoxy, butoxy, hydroxyl, mercapto,
10 methylthio, ethylthio, cyano, fluoromethyl,
difluoromethyl, trifluoromethyl, chloromethyl,
dichloromethyl, trichloromethyl, pentafluoroethyl,
heptafluoropropyl, difluorochloromethyl,
dichlorofluoromethyl, difluoroethyl, difluoropropyl,
15 dichloroethyl, dichloropropyl, trifluoromethoxy,
hydroxymethyl, methoxymethyl and ethoxymethyl, and R⁸
is selected from methylsulfonyl, fluoromethylsulfonyl,
difluoromethylsulfonyl, trifluoromethylsulfonyl and
aminosulfonyl; or wherein further R³ and R⁴, if present,
20 together form methylenedioxy; or a pharmaceutically-
acceptable salt thereof.

Within Formula I there is a subclass of
compounds of high interest represented by Formula II:

25



wherein each of R¹ through R¹⁰ is independently
selected from hydrido, halo, alkyl, alkoxy, alkylthio,
30 cyano, haloalkyl, haloalkoxy, hydroxyalkyl,

alkoxyalkyl, hydroxyl, mercapto, alkylamino, alkylsulfonyl, haloalkylsulfonyl and aminosulfonyl; and wherein n is a number selected from 0, 1, 2 and 3; or a pharmaceutically-acceptable salt thereof.

5

A preferred class of compounds consists of those compounds of Formula II wherein n is a number selected from 0, 1 and 2; wherein each of R¹, R² and R⁴ through R¹⁰ is independently selected from hydrido, halo, lower alkyl, lower alkylamino, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, lower alkoxy, hydroxyl, mercapto, lower hydroxyalkyl and lower alkoxyalkyl; and wherein R³ is selected from lower alkylsulfonyl, lower haloalkylsulfonyl and aminosulfonyl; or wherein R⁸ and R⁹ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

A class of compounds of particular interest consists of those compounds of Formula II wherein each of R¹, R² and R⁴ through R¹⁰ is independently selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, methylamino, N,N-dimethylamino, trifluoromethoxy, hydroxymethyl, methoxymethyl and ethoxymethyl; and wherein R³ is selected from methylsulfonyl, fluoromethylsulfonyl, difluoromethylsulfonyl, trifluoromethylsulfonyl and aminosulfonyl; or wherein R⁸ and R⁹ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

A family of specific compounds of particular interest within Formula II consists of compounds and pharmaceutically-acceptable salts thereof as follows:

- 5 5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-
 yl]-1,3-benzodioxole;
10 2,6-dichloro-4-[6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-
 yl]phenol
15 5-(4-trifluoromethoxyphenyl)-6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
20 4-[6-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
 yl]benzenesulfonamide;
25 5-(2,4-difluorophenyl)-6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
30 5-(2,4-dichlorophenyl)-6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
35 5-(3-chloro-4-methylphenyl)-6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
40 5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
45 5-(3-chloro-4-trifluoromethoxyphenyl)-6-[4-
 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
50 4-[6-(3-methyl-4-
 trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
 yl]benzenesulfonamide;
55 4-[6-(3-chloro-4-
 trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
 yl]benzenesulfonamide;
60 5-phenyl-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-
 5-ene;
65 5-(4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]
 spiro[2.4]hept-5-ene;
70 5-(4-chlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro
 [2.4]hept-5-ene;
75 5-(4-bromophenyl)-6-[4-(methylsulfonyl)phenyl]spiro
 [2.4]hept-5-ene;

- 5-(4-iodophenyl)-6-[4-(methylsulfonyl)phenyl]spiro
[2.4]hept-5-ene;
- 5-(4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro
[2.4]hept-5-ene;
- 5 5-(4-ethylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro
[2.4]hept-5-ene;
- 5-(4-methoxyphenyl)-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-(4-methylthiophenyl)-6-[4-(methylsulfonyl)phenyl]
10 spiro[2.4]hept-5-ene;
- 5-(4-cyanophenyl)-6-[4-(methylsulfonyl)phenyl]spiro
[2.4]hept-5-ene;
- 5-(4-trifluoromethylphenyl)-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 15 5-(4-hydroxymethylphenyl)-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-(4-methoxymethylphenyl)-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-(4-hydroxyphenyl)-6-[4-(methylsulfonyl)
20 phenyl]spiro[2.4]hept-5-ene;
- 5-(4-mercaptophenyl)-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-[4-(N-methylamino)phenyl]-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 25 5-[4-(N,N-dimethylamino)phenyl]-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 4-(6-phenylspiro[2.4]hept-5-en-5-yl)
benzenesulfonamide;
- 4-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]
30 benzenesulfonamide;
- 4-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
- 4-[6-(4-bromophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
- 35 4-[6-(4-iodophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
- 4-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]

benzenesulfonamide;
4-[6-(4-ethylphenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]
5 benzenesulfonamide;
4-[6-(4-methylthiophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-(4-cyanophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
10 4-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;
4-[6-(4-hydroxymethylphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;
4-[6-(4-methoxymethylphenyl)spiro[2.4]hept-5-en-5-
15 15 benzenesulfonamide;
4-[6-(4-hydroxyphenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-(4-mercaptophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
20 4-[6-[4-(N-methylamino)phenyl]spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-[4-(N,N-dimethylamino)phenyl]spiro[2.4]hept-5-en-5-
25 25 yl]benzenesulfonamide;
6-phenyl-7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-
6-ene;
6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
6-(4-chlorophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
30 30 6-(4-bromophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
6-(4-iodophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
6-(4-methylphenyl)-7-[4-(methylsulfonyl)phenyl]
35 35 spiro[3.4]oct-6-ene;
6-(4-ethylphenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;

- 6-(4-methoxyphenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 6-(4-methylthiophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 5 6-(4-cyanophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 6-(4-trifluoromethylphenyl)-7-[4-(methylsulfonyl)
phenyl]spiro[3.4]oct-6-ene;
- 6-(4-hydroxymethylphenyl)-7-[4-(methylsulfonyl)
10 phenyl]spiro[3.4]oct-6-ene;
- 6-(4-methoxymethylphenyl)-7-[4-(methylsulfonyl)
phenyl]spiro[3.4]oct-6-ene;
- 6-(4-hydroxyphenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 15 6-(4-mercaptophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 4-(7-phenylspiro[3.4]oct-6-en-6-yl)
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- 4-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]
20 benzenesulfonamide;
- 4-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-bromophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 25 4-[7-(4-iodophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-ethylphenyl)spiro[3.4]oct-6-en-6-yl]
30 benzenesulfonamide;
- 4-[7-(4-methoxyphenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-methylthiophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 35 4-[7-(4-cyanophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-trifluoromethylphenyl)spiro[3.4]oct-6-en-6-

yl]benzenesulfonamide;
4-[7-(4-hydroxymethylphenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(4-methoxymethylphenyl)spiro[3.4]oct-6-en-6-yl]
5 benzenesulfonamide;
4-[7-(4-hydroxyphenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(4-mercaptophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
10 2-phenyl-3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-ene;
2-(4-fluorophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
2-(4-chlorophenyl)-3-[4-(methylsulfonyl)phenyl]
15 spiro[4.4]non-2-ene;
2-(4-bromophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
2-(4-iodophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
20 2-(4-methylphenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
2-(4-ethylphenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
2-(4-methoxyphenyl)-3-[4-(methylsulfonyl)phenyl]
25 spiro[4.4]non-2-ene;
2-(4-methylthiophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
2-(4-cyanophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
30 2-(4-trifluoromethylphenyl)-3-[4-(methylsulfonyl)
phenyl]spiro[4.4]non-2-ene;
2-(4-hydroxymethylphenyl)-3-[4-(methylsulfonyl)
35 phenyl]spiro[4.4]non-2-ene;
2-(4-methoxymethylphenyl)-3-[4-(methylsulfonyl)
phenyl]spiro[4.4]non-2-ene;
2-(4-hydroxyphenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;

- 2-(4-mercaptophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
- 4-(3-phenylspiro[4.4]non-2-en-2-yl)
benzenesulfonamide;
- 5 4-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-bromophenyl)spiro[4.4]non-2-en-2-yl]
10 benzenesulfonamide;
- 4-[3-(4-iodophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 15 4-[3-(4-ethylphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-methoxyphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-methylthiophenyl)spiro[4.4]non-2-en-2-yl]
20 benzenesulfonamide;
- 4-[3-(4-cyanophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-trifluoromethylphenyl)spiro[4.4]non-2-en-2-
y1]benzenesulfonamide;
- 25 4-[3-(4-hydroxymethylphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-methoxymethylphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 4-[3-(4-hydroxyphenyl)spiro[4.4]non-2-en-2-yl]
30 benzenesulfonamide;
- 4-[3-(4-mercaptophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
- 5-(3-trifluoromethyl-4-methylphenyl)-
- 35 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-fluorophenyl)-
- 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-chlorophenyl)-

- 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-trifluoromethyl-4-bromophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-fluorophenyl)-
5 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-chlorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-bromophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
10 5-(3-methyl-4-trifluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-trifluoromethyl-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-methoxyphenyl)-
15 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-fluoro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-chloro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
20 5-(3-bromo-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4,5,6-pentafluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(4-methoxy-2,3,5,6-tetrafluorophenyl)-
25 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,5,6-tetrafluoro-4-trifluoromethylphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-difluoro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
30 5-(3,5-dichloro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-dibromo-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-trifluoro-4-methoxyphenyl)-
35 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-trichloro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

- 5-(2,3,4-tribromo-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(2,4,5-trifluoro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5 5-(2,4,5-trichloro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(2,4,5-tribromo-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dimethoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 10 5-(3,4,5-trimethoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-[3,4-bis(trifluoromethyl)phenyl]-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 15 5-(3,4-dimethylphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-difluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dichlorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 20 5-(3,4-dibromophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-chloro-4-fluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 25 5-(3-chloro-4-bromophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-chloro-3-fluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-chloro-3-bromophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 30 5-(3-trifluoromethyl-4-methylphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-fluorophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 35 5-(3-trifluoromethyl-4-chlorophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-bromophenyl)-6-[4-

(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-fluorophenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-chlorophenyl)-6-[4-
5 (fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-bromophenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-trifluorophenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
10 5-(3-trifluoromethyl-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-fluoro-4-methoxyphenyl)-6-[4-
15 (fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-chloro-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-bromo-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
20 5-(2,3,4,5,6-pentafluorophenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(4-methoxy-2,3,5,6-tetrafluorophenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,5,6-tetrafluoro-4-trifluoromethylphenyl)-6-[4-
25 (fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-difluoro-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-dichloro-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
30 5-(3,5-dibromo-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-trifluoro-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-trichloro-4-methoxyphenyl)-6-[4-
35 (fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-tribromo-4-methoxyphenyl)-6-[4-
(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

- 5-(2,4,5-trifluoro-4-methoxyphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(2,4,5-trichloro-4-methoxyphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5 5-(2,4,5-tribromo-4-methoxyphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dimethoxyphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 10 5-(3,4,5-trimethoxyphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-[3,4-bis(trifluoromethyl)phenyl]-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dimethylphenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 15 5-(3,4-difluorophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dichlorophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dibromophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 20 5-(3-chloro-4-fluorophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-chloro-4-bromophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 25 5-(4-chloro-3-fluorophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-chloro-3-bromophenyl)-6-[4-(fluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-methylphenyl)-6-[4-(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 30 5-(3-trifluoromethyl-4-fluorophenyl)-6-[4-(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-chlorophenyl)-6-[4-(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 35 5-(3-trifluoromethyl-4-bromophenyl)-6-[4-(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-methyl-4-fluorophenyl)-6-[4-

(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-chlorophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-bromophenyl)-6-[4-
5 (difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-trifluorophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-trifluoromethyl-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
10 5-(3-methyl-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-fluoro-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-chloro-4-methoxyphenyl)-6-[4-
15 (difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-bromo-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4,5,6-pentafluorophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
20 5-(4-methoxy-2,3,5,6-tetrafluorophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,5,6-tetrafluoro-4-trifluoromethylphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-difluoro-4-methoxyphenyl)-6-[4-
25 (difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-dichloro-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,5-dibromo-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
30 5-(2,3,4-trifluoro-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-trichloro-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,3,4-tribromo-4-methoxyphenyl)-6-[4-
35 (difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,4,5-trifluoro-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

- 5-(2,4,5-trichloro-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(2,4,5-tribromo-4-methoxyphenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5 5-(3,4-dimethoxyphenyl)-6-[4-(difluoromethylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4,5-trimethoxyphenyl)-6-[4-(difluoromethylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-[3,4-bis(trifluoromethyl)phenyl]-6-[4-
10 (difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dimethylphenyl)-6-[4-(difluoromethylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-difluorophenyl)-6-[4-(difluoromethylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;
- 15 5-(3,4-dichlorophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,4-dibromophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-chloro-4-fluorophenyl)-6-[4-
20 (difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-chloro-4-bromophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-chloro-3-fluorophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 25 5-(4-chloro-3-bromophenyl)-6-[4-
(difluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-trifluoromethyl-4-methylphenyl)-6-[4-
(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-
ene;
- 30 5-(3-trifluoromethyl-4-fluorophenyl)-6-[4-
(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-
ene;
- 5-(3-trifluoromethyl-4-chlorophenyl)-6-[4-
(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-
ene;
- 35 5-(3-trifluoromethyl-4-bromophenyl)-6-[4-
(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-

- ene;
- 5-(3-methyl-4-fluorophenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5 5-(3-methyl-4-chlorophenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 10 5-(3-methyl-4-bromophenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 15 5-(3-methyl-4-trifluorophenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 20 5-(3-trifluoromethyl-4-methoxyphenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 25 5-(3-methyl-4-methoxyphenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 30 5-(3-fluoro-4-methoxyphenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 35 5-(3-chloro-4-methoxyphenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 40 5-(3-bromo-4-methoxyphenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 45 5-(2,3,4,5,6-pentafluorophenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 50 5-(4-methoxy-2,3,5,6-tetrafluorophenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 55 5-(2,3,5,6-tetrafluoro-4-trifluoromethylphenyl)-6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

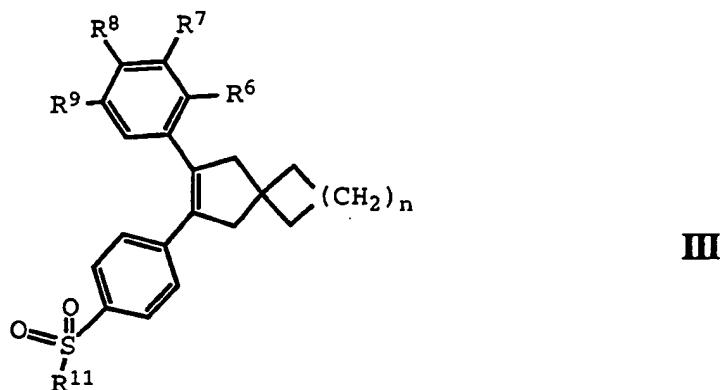
- 5-(3,5-difluoro-4-methoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(3,5-dichloro-4-methoxyphenyl)-
5 6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(3,5-dibromo-4-methoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 10 5-(2,3,4-trifluoro-4-methoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(2,3,4-trichloro-4-methoxyphenyl)-
15 6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(2,3,4-tribromo-4-methoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(2,4,5-trifluoro-4-methoxyphenyl)-
20 6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(2,4,5-trichloro-4-methoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 25 5-(2,4,5-tribromo-4-methoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(3,4-dimethoxyphenyl)-
30 6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(3,4,5-trimethoxyphenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-[3,4-bis(trifluoromethyl)phenyl]-
35 6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
- 5-(3,4-dimethylphenyl)-

6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
5-(3,4-difluorophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
5-(3,4-dichlorophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
5-(3,4-dibromophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
5-(3-chloro-4-fluorophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
15 5-(3-chloro-4-bromophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
5-ene;
5-(4-chloro-3-fluorophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]hept-
20 5-ene;
5-(4-chloro-3-bromophenyl)-
6-[4-(trifluoromethylsulfonyl)phenyl]spiro[2.4]
hept-5-ene;
4-[6-(3-methyl-4-fluorophenyl)spiro[2.4]hept-
25 5-en-5-yl]benzenesulfonamide;
4-[6-(3-methyl-4-chlorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3-methyl-4-bromophenyl)spiro[2.4]hept-
30 5-en-5-yl]benzenesulfonamide;
4-[6-(3-methyl-4-trifluoromethylphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3-methyl-4-methoxyphenyl)spiro[2.4]hept-
35 5-en-5-yl]benzenesulfonamide;
4-[6-(3-trifluoromethyl-4-fluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3-trifluoromethyl-4-chlorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;

- 4-[6-(3-trifluoromethyl-4-bromophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3-trifluoromethyl-4-methylphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 5 4-[6-(3-trifluoromethyl-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3-fluoro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3-chloro-4-methoxyphenyl)spiro[2.4]hept-
10 5-en-5-yl]benzenesulfonamide;
- 4-[6-(3-bromo-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,3,4,5,6-pentafluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 15 4-[6-(4-methoxy-2,3,5,6-tetrafluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,3,5,6-tetrafluoro-4-
trifluoromethylphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 20 4-[6-(3,5-difluoro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3,5-dichloro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3,5-dibromo-4-methoxyphenyl)spiro[2.4]hept-
25 5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,3,4-trifluoro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,3,4-trichloro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 30 4-[6-(2,3,4-tribromo-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,4,5-trifluoro-4-methoxyphenyl)spiro[2.4]hept-
35 5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,4,5-trichloro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(2,4,5-tribromo-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;

- 4-[6-(3,4-dimethoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3,4,5-trimethoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 5 4-[6-[3,4-bis(trifluoromethyl)phenyl]spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3,4-dimethylphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3,4-difluorophenyl)spiro[2.4]hept-
10 5-en-5-yl]benzenesulfonamide;
4-[6-(3,4-dibromophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3-chloro-4-fluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 15 4-[6-(3-chloro-4-bromophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(4-chloro-3-fluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide; and
4-[6-(4-chloro-3-bromophenyl)spiro[2.4]hept-
20 5-en-5-yl]benzenesulfonamide.

Within Formula I there is a second subclass of compounds of high interest represented by Formula III:



25

wherein n is a number selected from 0, 1 and 2;
wherein R⁶ is selected from hydrido and halo;
wherein R⁷ is selected from hydrido and halo;

wherein R⁸ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower haloalkyl, lower haloalkoxy, and hydroxyl;

5 wherein R⁹ is selected from hydrido, halo, and lower alkyl; or wherein R⁸ and R⁹ together form methylenedioxy; and

wherein R¹¹ is selected from lower alkyl and amino;

or a pharmaceutically-acceptable salt thereof.

10

A class of compounds of particular interest consists of those compounds of Formula III wherein R⁶ is selected from hydrido, fluoro, chloro, bromo, and iodo; wherein R⁷ is selected from hydrido, fluoro, chloro, bromo, and iodo; wherein R⁸ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, and trifluoromethoxy; wherein R⁹ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, and isobutyl; or where R⁸ and R⁹ together form methylenedioxy; and wherein R¹¹ is methyl or amino; and or a pharmaceutically-acceptable salt thereof.

20

A family of specific compounds of particular interest within Formula III consists of compounds and pharmaceutically-acceptable salts thereof as follows:

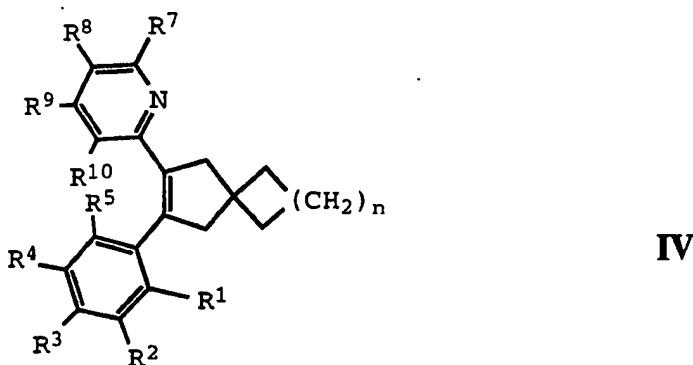
35 5-(3-chloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

- 4-[6-(3-chloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 5-(3-fluoro-4-methoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5 4-[6-(3-fluoro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 5-(3,4-difluorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-
10 yl]-1,3-benzodioxole;
- 4-[6-(3,4-difluorophenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 2,6-dichloro-4-[6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-
15 yl]phenol
- 5-(4-trifluoromethoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-methoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 20 5-(3-bromo-4-methoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 4-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 4-[6-(3-bromo-4-methoxyphenyl)spiro[2.4]hept-5-en-5-
25 yl]benzenesulfonamide;
- 5-(4-trifluoromethylphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3,5-dichloro-4-methoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 30 4-[6-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 5-(3-chloro-4-fluorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(2,4-difluorophenyl)-6-[4-
35 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(2,4-dichlorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

- 4-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 4-[6-(3-chloro-4-fluorophenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 5 5-(3,4-dichlorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-chlorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 4-[6-(3,4-dichlorophenyl)spiro[2.4]hept-5-en-5-
10 yl]benzenesulfonamide;
- 4-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 5-(3-chloro-4-methylphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 15 5-(3,4-dimethylphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(4-methylphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-
20 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5-(3-chloro-4-trifluoromethoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 4-[6-(3,5-dichloro-4-methoxyphenyl)spiro[2.4]hept-5-
en-5-yl]benzenesulfonamide;
- 25 4-[6-(3-methyl-4-
trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 4-[6-(3-chloro-4-
30 trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 5-(4-fluorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 4-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
- 35 6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-5-ene;
- 4-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]

benzenesulfonamide; and
 2-(4-fluorophenyl)-3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-5-ene.

5 Within Formula I there is a third subclass of compounds of high interest represented by Formula IV:



10 wherein n is a number selected from 0, 1, 2 and 3; and wherein each of R¹ through R⁵ and R⁷ through R¹⁰ is independently selected from hydrido, halo, alkyl, alkoxy, alkylthio, cyano, haloalkyl, haloalkoxy, alkylamino, hydroxyalkyl, alkoxyalkyl, hydroxyl, 15 mercapto, alkylsulfonyl, haloalkylsulfonyl and aminosulfonyl; or a pharmaceutically-acceptable salt thereof.

A preferred class of compounds consists of 20 those compounds of Formula IV wherein n is a number selected from 0, 1 and 2; wherein each of R¹, R², R⁴, R⁵, R⁷, R⁹ and R¹⁰ is independently selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, 25 lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and mercapto; and wherein R³ is selected from lower alkylsulfonyl and aminosulfonyl and R⁸ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower haloalkoxy, lower hydroxyalkyl, lower alkylamino, mercapto, hydroxyl, lower alkoxyalkyl,

cyano and lower haloalkyl; or wherein further R⁸ and R⁹ together form methylenedioxy; or wherein further, R³ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower haloalkoxy, lower alkylamino,
5 lower hydroxyalkyl, hydroxyl, mercapto, lower alkoxyalkyl, cyano and lower haloalkyl, and R⁸ is selected from lower alkylsulfonyl and aminosulfonyl; or wherein further R³ and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

10

A class of compounds of particular interest consists of those compounds of Formula IV wherein each of R¹, R², R⁴, R⁵, R⁷, R⁹ and R¹⁰ is hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl,
15 isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl,
• 20 heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, methylamino, N,N-dimethylamino, trifluoromethoxy, hydroxymethyl, methoxymethyl and ethoxymethyl; and wherein R³ is
25 methylsulfonyl or aminosulfonyl, and R⁸ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, trifluoromethoxy, methylamino, N,N-dimethylamino,
30 methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl,
35 dichloroethyl and dichloropropyl; or wherein further R⁸ and R⁹ together form methylenedioxy; or wherein further, R³ is selected from hydrido, fluoro, chloro,

bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, trifluoromethoxy, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl,
5 chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl and dichloropropyl, and R⁸ is methylsulfonyl or
10 aminosulfonyl; or wherein further R³ and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

A family of specific compounds of particular interest within Formula IV consists of compounds and pharmaceutically-acceptable salts thereof as follows:

2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
20 5-fluoro-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
5-chloro-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
5-methyl-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
25 5-methoxy-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
5-methylthio-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
30 5-cyano-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
5-trifluoromethyl-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
4-[6-(pyridin-2-yl)spiro[2.4]hept-5-en-5-yl]
35 benzenesulfonamide;
4-[6-(5-fluoropyridin-2-yl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;

4-[6-(5-chloropyridin-2-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-(5-methylpyridin-2-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
5 4-[6-(5-methoxypyridin-2-yl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
4-[6-(5-methylthiopyridin-2-yl)spiro[2.4]hept-5-en-
5-yl]benzenesulfonamide;
4-[6-(5-cyanopyridin-2-yl)spiro[2.4]hept-5-en-5-yl]
10 benzenesulfonamide;
4-[6-(5-trifluoromethylpyridin-2-yl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
2-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-
yl]pyridine;
15 5-fluoro-2-[7-[4-(methylsulfonyl)
phenyl]spiro[3.4]oct-6-en-6-yl]pyridine;
5-chloro-2-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;
5-methyl-2-[7-[4-(methylsulfonyl)phenyl]
20 spiro[3.4]oct-6-en-6-yl]pyridine;
5-methoxy-2-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]
oct-6-en-6-yl]pyridine;
5-methylthio-2-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;
25 5-cyano-2-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;
5-trifluoromethyl-2-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;
4-[7-(pyridin-2-yl)spiro[3.4]oct-6-en-6-yl]
30 benzenesulfonamide;
4-[7-(5-fluoropyridin-2-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(5-chloropyridin-2-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
35 4-[7-(5-methylpyridin-2-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(5-methoxypyridin-2-yl)spiro[3.4]oct-6-en-6-yl]

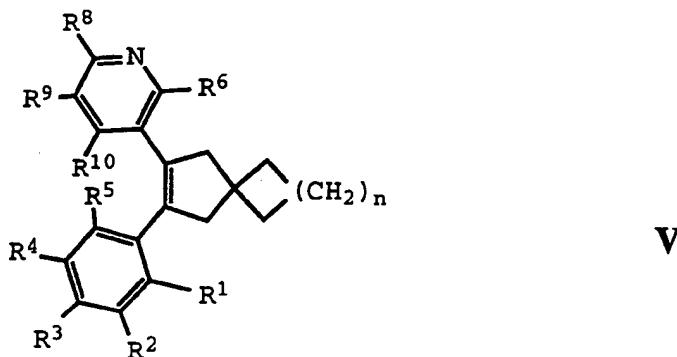
benzenesulfonamide;
4-[7-(5-methylthiopyridin-2-yl)spiro[3.4]oct-6-en-6-
yl]benzenesulfonamide;
4-[7-(5-cyanopyridin-2-yl)spiro[3.4]oct-6-en-6-yl]
5 benzenesulfonamide;
4-[7-(5-trifluoromethylpyridin-2-yl)spiro[3.4]oct-6-
en-6-yl]benzenesulfonamide;
2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-en-2-
yl]pyridine;
10 5-fluoro-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]
non-2-en-2-yl]pyridine;
5-chloro-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]
non-2-en-2-yl]pyridine;
5-methyl-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]
15 non-2-en-2-yl]pyridine;
5-methoxy-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]
non-2-en-2-yl]pyridine;
5-methylthio-2-[3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-en-2-yl]pyridine;
20 5-cyano-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]
non-2-en-2-yl]pyridine;
5-trifluoromethyl-2-[3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-en-2-yl]pyridine;
4-[3-(pyridin-2-yl)spiro[4.4]non-2-en-2-yl]
25 benzenesulfonamide;
4-[3-(5-fluoropyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(5-chloropyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
30 4-[3-(5-methylpyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(5-methoxypyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(5-methylthiopyridin-2-yl)spiro[4.4]non-2-en-2-
35 yl]benzenesulfonamide;
4-[3-(5-cyanopyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

- 4-[3-(5-trifluoromethylpyridin-2-yl)spiro[4.4]non-2-en-2-yl]benzenesulfonamide;
- 2-(6-phenylspiro[2.4]hept-5-en-5-yl)-5-(methylsulfonyl)pyridine;
- 5 2-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 2-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 2-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 10 2-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 2-[6-(4-methylthiophenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 15 2-[6-(4-cyanophenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 2-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-yl]-5-(methylsulfonyl)pyridine;
- 2-(6-phenylspiro[2.4]hept-5-en-5-yl)-5-
- 20 pyridinesulfonamide;
- 2-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-5-pyridinesulfonamide;
- 2-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-5-pyridinesulfonamide;
- 25 2-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-5-pyridinesulfonamide;
- 2-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]-5-pyridinesulfonamide;
- 2-[6-(4-methylthiophenyl)spiro[2.4]hept-5-en-5-yl]-
- 30 5-pyridinesulfonamide;
- 2-[6-(4-cyanophenyl)spiro[2.4]hept-5-en-5-yl]-5-pyridinesulfonamide;
- 2-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-yl]-5-pyridinesulfonamide;
- 35 2-(7-phenylspiro[3.4]oct-6-en-6-yl)-5-(methylsulfonyl)pyridine;
- 2-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-5-

(methylsulfonyl)pyridine;
2-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
2-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-5-
5(methylsulfonyl)pyridine;
2-[7-(4-methoxyphenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
2-[7-(4-methylthiophenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
10 2-[7-(4-cyanophenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
2-[7-(4-trifluoromethylphenyl)spiro[3.4]oct-6-en-6-
y1]-5-(methylsulfonyl)pyridine;
2-(7-phenylspiro[3.4]oct-6-en-6-yl)-5-
15 pyridinesulfonamide;
2-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-5-
pyridinesulfonamide;
2-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-5-
pyridinesulfonamide;
20 2-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-5-
pyridinesulfonamide;
2-[7-(4-methoxyphenyl)spiro[3.4]oct-6-en-6-yl]-5-
pyridinesulfonamide;
2-[7-(4-methylthiophenyl)spiro[3.4]oct-6-en-6-yl]-5-
25 pyridinesulfonamide;
2-[7-(4-cyanophenyl)spiro[3.4]oct-6-en-6-yl]-5-
pyridinesulfonamide;
2-[7-(4-trifluoromethylphenyl)spiro[3.4]oct-6-en-6-
y1]-5-pyridinesulfonamide;
30 2-(3-phenylspiro[4.4]non-2-en-2-yl)-5-(methylsulfonyl)pyridine;
2-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
2-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-5-
35(methylsulfonyl)pyridine;
2-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;

- 2-[3-(4-methoxyphenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
- 2-[3-(4-methylthiophenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
- 5 2-[3-(4-cyanophenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
- 2-[3-(4-trifluoromethylphenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
- 2-(3-phenylspiro[4.4]non-2-en-2-yl)-5-
- 10 pyridinesulfonamide;
- 2-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide;
- 2-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide;
- 15 2-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide;
- 2-[3-(4-methoxyphenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide;
- 2-[3-(4-cyanophenyl)spiro[4.4]non-2-en-2-yl]-5-
- 20 pyridinesulfonamide; and
- 2-[3-(4-trifluoromethylphenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide.

Within Formula I there is a fourth subclass of
25 compounds of high interest represented by Formula V:



wherein n is a number selected from 0, 1, 2 and 3;
30 and

wherein each of R¹ through R⁶ and R⁸ through R¹⁰ is independently selected from hydrido, halo, alkyl, alkoxy, alkylthio, cyano, haloalkyl, haloalkoxy, hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto, 5 alkylamino, alkylsulfonyl and aminosulfonyl; or a pharmaceutically-acceptable salt thereof.

A preferred class of compounds consists of those compounds of Formula V wherein n is a number 10 selected from 0, 1 and 2; wherein each of R¹, R², R⁴, R⁵, R⁶, R⁹ and R¹⁰ is independently selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and 15 mercapto; and wherein R³ is selected from lower alkylsulfonyl and aminosulfonyl and R⁸ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower alkylamino, lower haloalkoxy, lower hydroxyalkyl, mercapto, hydroxyl, lower alkoxyalkyl, 20 cyano and lower haloalkyl; or wherein further R⁸ and R⁹ together form methylenedioxy; or wherein further, R³ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower alkylamino, lower haloalkoxy, lower hydroxyalkyl, hydroxyl, lower alkoxyalkyl, cyano 25 and lower haloalkyl, and R⁸ is selected from lower alkylsulfonyl and aminosulfonyl; or wherein further R³ and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

30 A class of compounds of particular interest consists of those compounds of Formula V wherein each of R¹, R², R⁴, R⁵, R⁶, R⁹ and R¹⁰ is hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, 35 ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl,

heptafluoropropyl, difluorochloromethyl,
dichlorofluoromethyl, difluoroethyl, difluoropropyl,
dichloroethyl, dichloropropyl, trifluoromethoxy,
hydroxymethyl, methoxymethyl and ethoxymethyl; and
5 wherein R³ is methylsulfonyl or aminosulfonyl, and R⁸
is selected from hydrido, fluoro, chloro, bromo, iodo,
methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl,
isobutyl, methoxy, ethoxy, propoxy, butoxy,
trifluoromethoxy, methylamino, N,N-dimethylamino,
10 hydroxyl, methylthio, ethylthio, cyano, mercapto,
fluoromethyl, difluoromethyl, trifluoromethyl,
chloromethyl, dichloromethyl, trichloromethyl,
pentafluoroethyl, heptafluoropropyl,
difluorochloromethyl, dichlorofluoromethyl,
15 difluoroethyl, difluoropropyl, dichloroethyl and
dichloropropyl; or wherein further R⁸ and R⁹ together
form methylenedioxy; or wherein further, R³ is selected
from hydrido, fluoro, chloro, bromo, iodo, methyl,
ethyl, n-propyl, isopropyl, butyl, tert-butyl,
20 isobutyl, methoxy, ethoxy, propoxy, butoxy,
trifluoromethoxy, hydroxyl, methylamino, N,N-
dimethylamino, methylthio, ethylthio, cyano, mercapto,
fluoromethyl, difluoromethyl, trifluoromethyl,
chloromethyl, dichloromethyl, trichloromethyl,
25 pentafluoroethyl, heptafluoropropyl,
difluorochloromethyl, dichlorofluoromethyl,
difluoroethyl, difluoropropyl, dichloroethyl and
dichloropropyl, and R⁸ is methylsulfonyl or
aminosulfonyl; or wherein further R³ and R⁴ together
30 form methylenedioxy; or a pharmaceutically-acceptable
salt thereof.

A family of specific compounds of particular
interest within Formula V consists of compounds and
35 pharmaceutically-acceptable salts thereof as follows:

5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-
5-yl]pyridine;

2-fluoro-5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]
hept-5-en-5-yl]pyridine;

2-chloro-5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]
hept-5-en-5-yl]pyridine;

5 2-methyl-5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]
hept-5-en-5-yl]pyridine;

2-methoxy-5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]
hept-5-en-5-yl]pyridine;

2-methylthio-5-[6-[4-(methylsulfonyl)phenyl]
10 spiro[2.4]hept-5-en-5-yl]pyridine;

2-cyano-5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]
hept-5-en-5-yl]pyridine;

2-trifluoromethyl-5-[6-[4-(methylsulfonyl)phenyl]
spiro[2.4]hept-5-en-5-yl]pyridine;

15 4-[6-(pyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(2-fluoropyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(2-chloropyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
20 benzenesulfonamide;

4-[6-(2-methylpyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(2-methoxypyridin-5-yl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;

25 4-[6-(2-methylthiopyridin-5-yl)spiro[2.4]hept-5-en-
5-yl]benzenesulfonamide;

4-[6-(2-cyanopyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(2-trifluoromethylpyridin-5-yl)spiro[2.4]hept-
30 5-en-5-yl]benzenesulfonamide;

5-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-
yl]pyridine;

2-fluoro-5-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;

35 2-chloro-5-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;

2-methyl-5-[7-[4-(methylsulfonyl)phenyl]

spiro[3.4]oct-6-en-6-yl]pyridine;
2-methoxy-5-[7-[4-(methylsulfonyl)phenyl]spiro
[3.4]oct-6-en-6-yl]pyridine;
2-methylthio-5-[7-[4-(methylsulfonyl)phenyl]spiro
5 [3.4]oct-6-en-6-yl]pyridine;
2-cyano-5-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;
2-trifluoromethyl-5-[7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-en-6-yl]pyridine;
10 4-[7-(pyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(2-fluoropyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(2-chloropyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
15 benzenesulfonamide;
4-[7-(2-methylpyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(2-methoxypyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
20 4-[7-(2-methylthiopyridin-5-yl)spiro[3.4]oct-6-en-6-
yl]benzenesulfonamide;
4-[7-(2-cyanopyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(2-trifluoromethylpyridin-5-yl)spiro[3.4]oct-6-
25 en-6-yl]benzenesulfonamide;
5-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-en-2-
yl]pyridine;
2-fluoro-5-[3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-en-2-yl]pyridine;
30 2-chloro-5-[3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-en-2-yl]pyridine;
2-methyl-5-[3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-en-2-yl]pyridine;
2-methoxy-5-[3-[4-(methylsulfonyl)phenyl]
35 spiro[4.4]non-2-en-2-yl]pyridine;
2-methylthio-5-[3-[4-(methylsulfonyl)phenyl]spiro
[4.4]non-2-en-2-yl]pyridine;

2-trifluoromethyl-5-[3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-en-2-yl]pyridine;
4-[3-(pyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

5 4-[3-(2-fluoropyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

4-[3-(2-chloropyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

4-[3-(2-methylpyridin-5-yl)spiro[4.4]non-2-en-2-yl]
10 benzenesulfonamide;

4-[3-(2-methoxypyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

4-[3-(2-methylthiopyridin-5-yl)spiro[4.4]non-2-en-2-
y1]benzenesulfonamide;

15 4-[3-(2-cyanopyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

4-[3-(2-trifluoromethylpyridin-5-yl)spiro[4.4]non-2-
en-2-yl]benzenesulfonamide;

5-(6-phenylspiro[2.4]hept-5-en-5-yl)-2-
20 (methylsulfonyl)pyridine;

5-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

5-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

25 5-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

5-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

5-[6-(4-methylthiophenyl)spiro[2.4]hept-5-en-5-yl]-
30 2-(methylsulfonyl)pyridine;

5-[6-(4-cyanophenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

5-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-
y1]-2-(methylsulfonyl)pyridine;

35 5-(6-phenylspiro[2.4]hept-5-en-5-yl)-2-
pyridinesulfonamide;

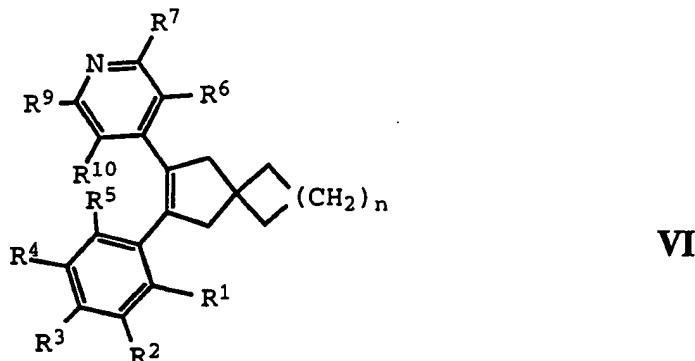
5-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-2-

- pyridinesulfonamide;
5-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
pyridinesulfonamide;
5-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-2-
5 pyridinesulfonamide;
5-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]-2-
pyridinesulfonamide;
5-[6-(4-methylthiophenyl)spiro[2.4]hept-5-en-5-yl]-
2-pyridinesulfonamide;
10 5-[6-(4-cyanophenyl)spiro[2.4]hept-5-en-5-yl]-2-
pyridinesulfonamide;
5-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-
yl]-2-pyridinesulfonamide;
5-(7-phenylspiro[3.4]oct-6-en-6-yl)-2-
15 (methylsulfonyl)pyridine;
5-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-2-
(methylsulfonyl)pyridine;
5-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-2-
(methylsulfonyl)pyridine;
20 5-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-2-
(methylsulfonyl)pyridine;
5-[7-(4-methoxyphenyl)spiro[3.4]oct-6-en-6-yl]-2-
(methylsulfonyl)pyridine;
5-[7-(4-methylthiophenyl)spiro[3.4]oct-6-en-6-yl]-2-
25 (methylsulfonyl)pyridine;
5-[7-(4-cyanophenyl)spiro[3.4]oct-6-en-6-yl]-2-
(methylsulfonyl)pyridine;
5-[7-(4-trifluoromethylphenyl)spiro[3.4]oct-6-en-6-
yl]-2-(methylsulfonyl)pyridine;
30 5-(7-phenylspiro[3.4]oct-6-en-6-yl)-2-
pyridinesulfonamide;
5-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-2-
pyridinesulfonamide;
5-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-2-
35 pyridinesulfonamide;
5-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-2-
pyridinesulfonamide;

- 5-[7-(4-methoxyphenyl)spiro[3.4]oct-6-en-6-yl]-2-pyridinesulfonamide;
- 5-[7-(4-cyanophenyl)spiro[3.4]oct-6-en-6-yl]-2-pyridinesulfonamide;
- 5-[7-(4-trifluoromethylphenyl)spiro[3.4]oct-6-en-6-yl]-2-pyridinesulfonamide;
- 5-(3-phenylspiro[4.4]non-2-en-2-yl)-2-(methylsulfonyl)pyridine;
- 5-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 15 5-[3-(4-methoxyphenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-[3-(4-methylthiophenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-[3-(4-cyanophenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 20 5-[3-(4-trifluoromethylphenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-(3-phenylspiro[4.4]non-2-en-2-yl)-2-pyridinesulfonamide;
- 25 5-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide;
- 5-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide;
- 5-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide;
- 30 5-[3-(4-methoxyphenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide;
- 5-[3-(4-methylthiophenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide;
- 35 5-[3-(4-cyanophenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide; and

5-[3-(4-trifluoromethylphenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide.

Within Formula I there is a fifth subclass of
5 compounds of high interest represented by Formula VI:



wherein n is a number selected from 0, 1, 2 and 3; and
10 wherein each of R¹ through R⁷, R⁹ and R¹⁰ is
independently selected from hydrido, halo, alkyl,
alkoxy, alkylthio, cyano, haloalkyl, haloalkoxy,
hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto,
alkylamino, alkylsulfonyl and aminosulfonyl; or a
15 pharmaceutically-acceptable salt thereof.

A preferred class of compounds consists of
those compounds of Formula VI wherein n is a number
selected from 0, 1 and 2; wherein each of R¹, R², R⁴
20 through R⁷, R⁹ and R¹⁰ is independently selected from
hydrido, halo, lower alkyl, lower alkoxy, lower
alkylthio, lower haloalkoxy, lower hydroxyalkyl,
hydroxyl, lower alkoxyalkyl, mercapto, cyano and lower
haloalkyl; and wherein R³ is selected from lower
25 alkylsulfonyl and aminosulfonyl; or a pharmaceutically-
acceptable salt thereof.

A class of compounds of particular interest
consists of those compounds of Formula VI wherein each
30 of R¹, R², R⁴ through R⁷, R⁹ and R¹⁰ is independently

- selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, trifluoromethoxy, methylthio, ethylthio, cyano,
- 5 hydroxyl, mercapto, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl,
- 10 dichloropropyl, hydroxymethyl, methoxymethyl and ethoxymethyl; and wherein R³ is methylsulfonyl or aminosulfonyl; or a pharmaceutically-acceptable salt thereof.
- 15 A family of specific compounds of particular interest within Formula VI consists of compounds and pharmaceutically-acceptable salts thereof as follows:
- 4-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-
20 5-yl]pyridine;
- 4-[6-(4-pyridinyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
- 4-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-
yl]pyridine;
- 25 4-[7-(4-pyridinyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-en-2-
yl]pyridine; and
- 4-[3-(4-pyridinyl)spiro[4.4]non-2-en-2-yl]
30 benzenesulfonamide.

Where the term "alkyl" is used, either alone or within other terms such as "haloalkyl", "alkylsulfonyl", "alkoxyalkyl" and "hydroxyalkyl", embraces linear or branched radicals having one to about twenty carbon atoms or, preferably, one to about twelve carbon atoms. More preferred alkyl radicals are "lower alkyl" radicals

having one to about ten carbon atoms. Most preferred are lower alkyl radicals having one to about six carbon atoms. Examples of such radicals include methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-
5 butyl, pentyl, iso-amyl, hexyl and the like. The term "hydrido" denotes a single hydrogen atom (H). This hydrido radical may be attached, for example, to an oxygen atom to form a "hydroxyl" radical, to a sulfur atom to form a "mercapto" radical, or two hydrido
10 radicals may be attached to a carbon atom to form a methylene (-CH₂-) radical. The term "halo" means halogens such as fluorine, chlorine, bromine or iodine. The term "haloalkyl" embraces radicals wherein any one or more of the alkyl carbon atoms is substituted with halo
15 as defined above. Specifically embraced are monohaloalkyl, dihaloalkyl and polyhaloalkyl radicals. A monohaloalkyl radical, for one example, may have either an iodo, bromo, chloro or fluoro atom within the radical. Dihalo and polyhaloalkyl radicals may have two or more of
20 the same halo atoms or a combination of different halo radicals. The term "hydroxyalkyl" embraces linear or branched alkyl radicals having one to about ten carbon atoms any one of which may be substituted with one or more hydroxyl radicals. The terms "alkoxy" and
25 "alkoxyalkyl" embrace linear or branched oxy-containing radicals each having alkyl portions of one to about ten carbon atoms. More preferred alkoxy radicals are "lower alkoxy" radicals having one to six carbon atoms. Examples of such radicals include methoxy, ethoxy,
30 propoxy, butoxy and tert-butoxy. The term "alkoxyalkyl" also embraces alkyl radicals having two or more alkoxy radicals attached to the alkyl radical, that is, to form monoalkoxyalkyl and dialkoxyalkyl radicals. The "alkoxy" or "alkoxyalkyl" radicals may be further
35 substituted with one or more halo atoms, such as fluoro, chloro or bromo, to provide "haloalkoxy" or "haloalkoxyalkyl" radicals. The term "alkylamino"

- embraces amino radicals having one or more alkyl radicals attached to the nitrogen atom, that is, to form N-alkylamino and N,N-dialkylamino radicals. The term "alkylthio" embraces radicals containing a linear or
5 branched alkyl radical, of one to about ten carbon atoms attached to a divalent sulfur atom, such as a methythio radical, (CH₃-S-). The term "sulfonyl", whether used alone or linked to other terms such as alkylsulfonyl, denotes respectively divalent radicals -SO₂--.
- 10 "Alkylsulfonyl" embraces alkyl radicals attached to a sulfonyl radical, where alkyl is defined as above. The "alkylsulfonyl" radicals may be further substituted with one or more halo atoms, such as fluoro, chloro or bromo, to provide "haloalkylsulfonyl" radicals. The terms
15 "aminosulfonyl" "sulfamyl" and "sulfonamidyl" denotes a sulfonyl radical substituted with an amine radical, forming a sulfonamide (-SO₂NH₂).

The present invention comprises a
20 pharmaceutical composition comprising a therapeutically-effective amount of a compound of Formula I in association with at least one pharmaceutically-acceptable carrier, adjuvant or diluent.

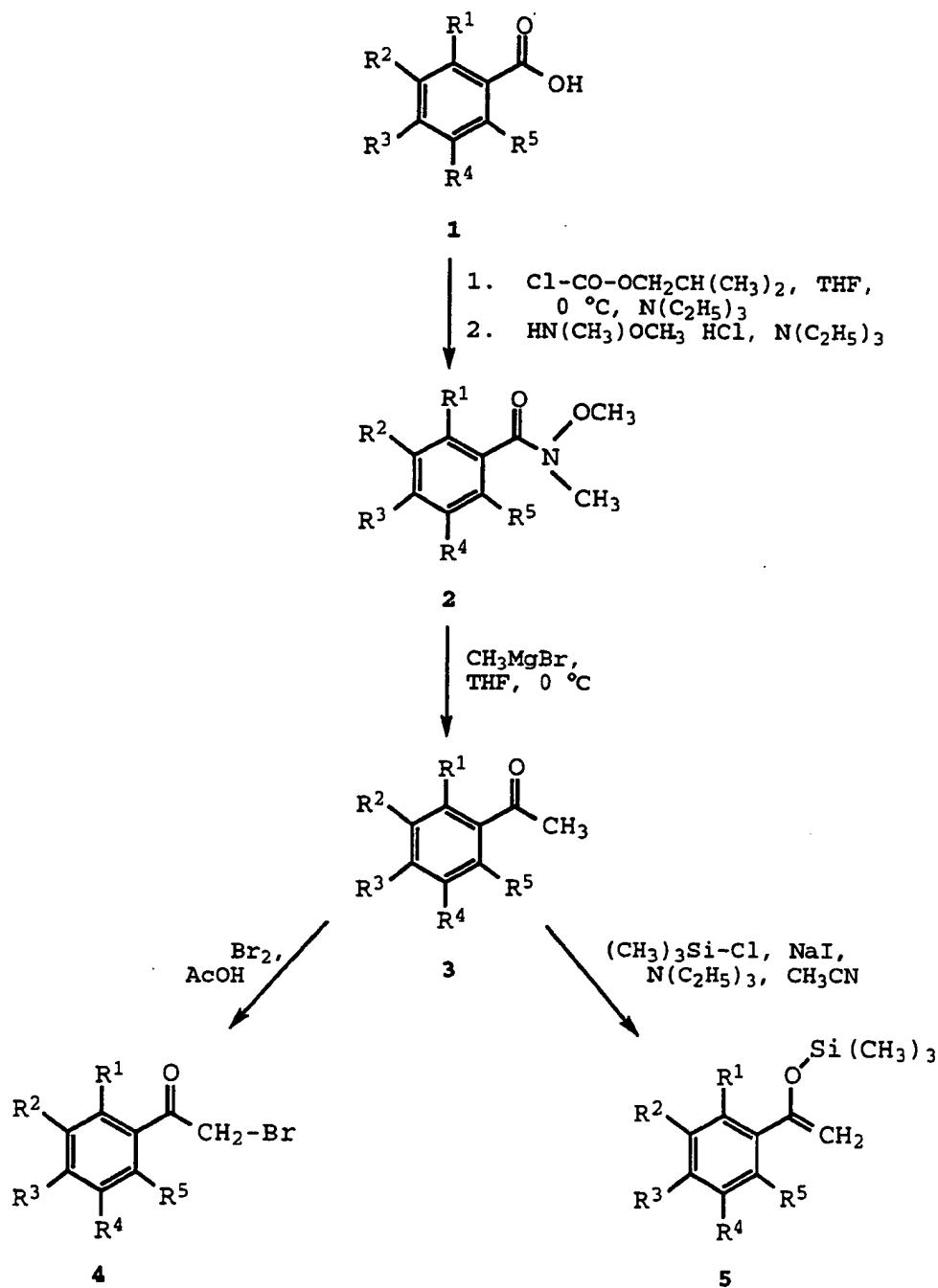
25 The present invention also comprises a method of treating inflammation or inflammation-associated disorders in a subject, the method comprising administering to the subject having such inflammation or disorder a therapeutically-effective amount of a compound
30 of Formula I.

Also included in the family of compounds of Formula I are the pharmaceutically-acceptable salts thereof. The term "pharmaceutically-acceptable salts"
35 embraces salts commonly used to form alkali metal salts and to form addition salts of free acids or free bases. The nature of the salt is not critical, provided that it

is pharmaceutically-acceptable. Suitable pharmaceutically-acceptable acid addition salts of compounds of Formula I may be prepared from an inorganic acid or from an organic acid. Examples of such inorganic acids are hydrochloric, hydrobromic, hydroiodic, nitric, carbonic, sulfuric and phosphoric acid. Appropriate organic acids may be selected from aliphatic, cycloaliphatic, aromatic, araliphatic, heterocyclic, carboxylic and sulfonic classes of organic acids, example 5 of which are formic, acetic, propionic, succinic, glycolic, gluconic, lactic, malic, tartaric, citric, ascorbic, glucuronic, maleic, fumaric, pyruvic, aspartic, glutamic, benzoic, anthranilic, mesylic, salicyclic, salicyclic, *p*-hydroxybenzoic, phenylacetic, mandelic, 10 embonic (pamoic), methanesulfonic, ethanesulfonic, benzenesulfonic, pantothenic, toluenesulfonic, 2-hydroxyethanesulfonic, sulfanilic, stearic, cyclohexylaminosulfonic, algenic, β -hydroxybutyric, salicyclic, galactaric and galacturonic acid. Suitable 15 pharmaceutically-acceptable base addition salts of compounds of Formula I include metallic salts made from aluminum, calcium, lithium, magnesium, potassium, sodium and zinc or organic salts made from N,N'-dibenzylethylenediamine, chloroprocaine, choline, diethanolamine, ethylenediamine, meglumine (N-methylglucamine) and procaine. All of these salts may be 20 prepared by conventional means from the corresponding compound of Formula I by reacting, for example, the appropriate acid or base with the compound of Formula I.

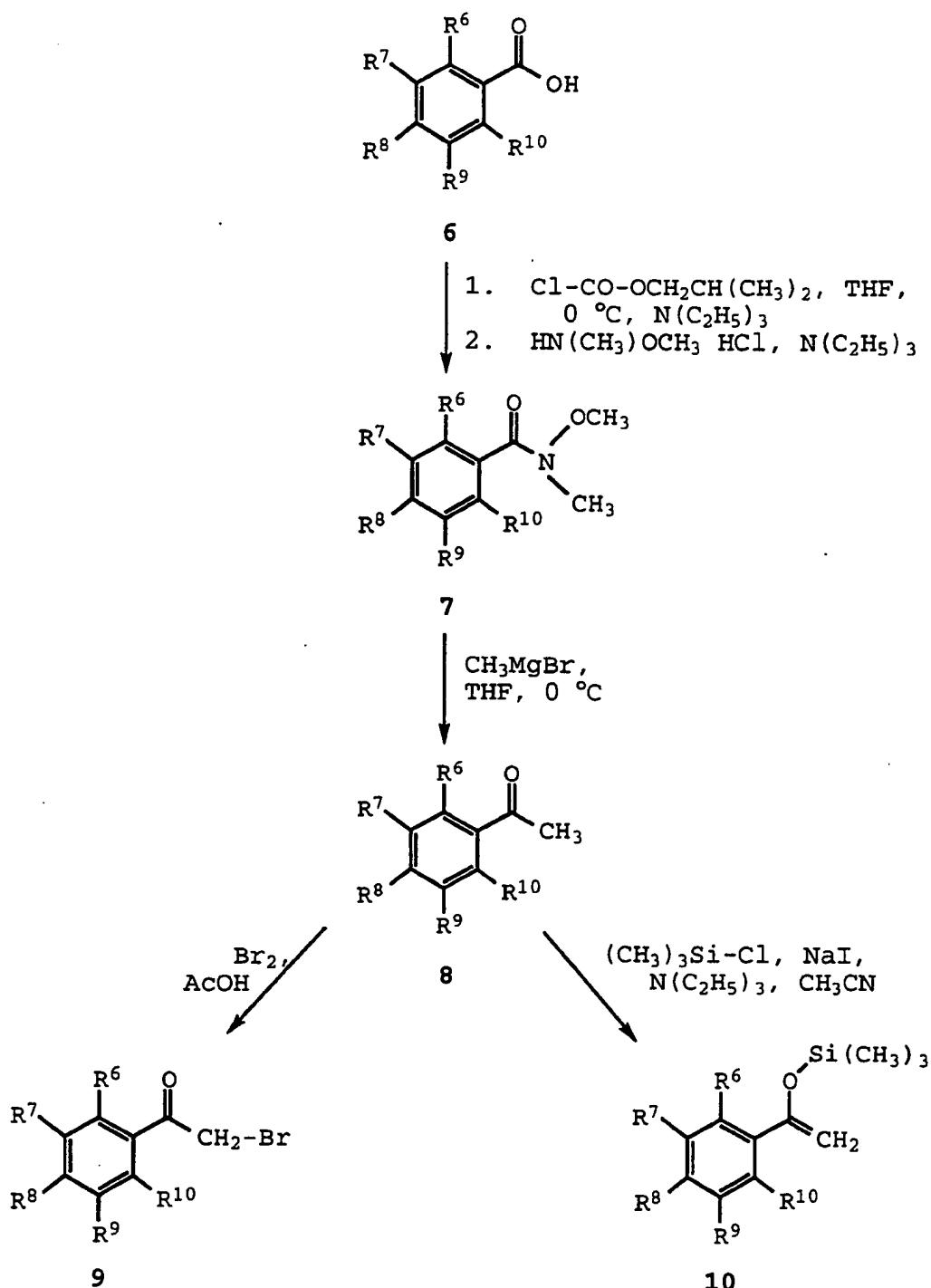
GENERAL SYNTHETIC PROCEDURES

The compounds of the invention can be synthesized according to the following procedures of
 5 Schemes I-XIX, wherein the R¹-R¹¹ substituents are as defined for Formula I, above, except where further noted.

Scheme I

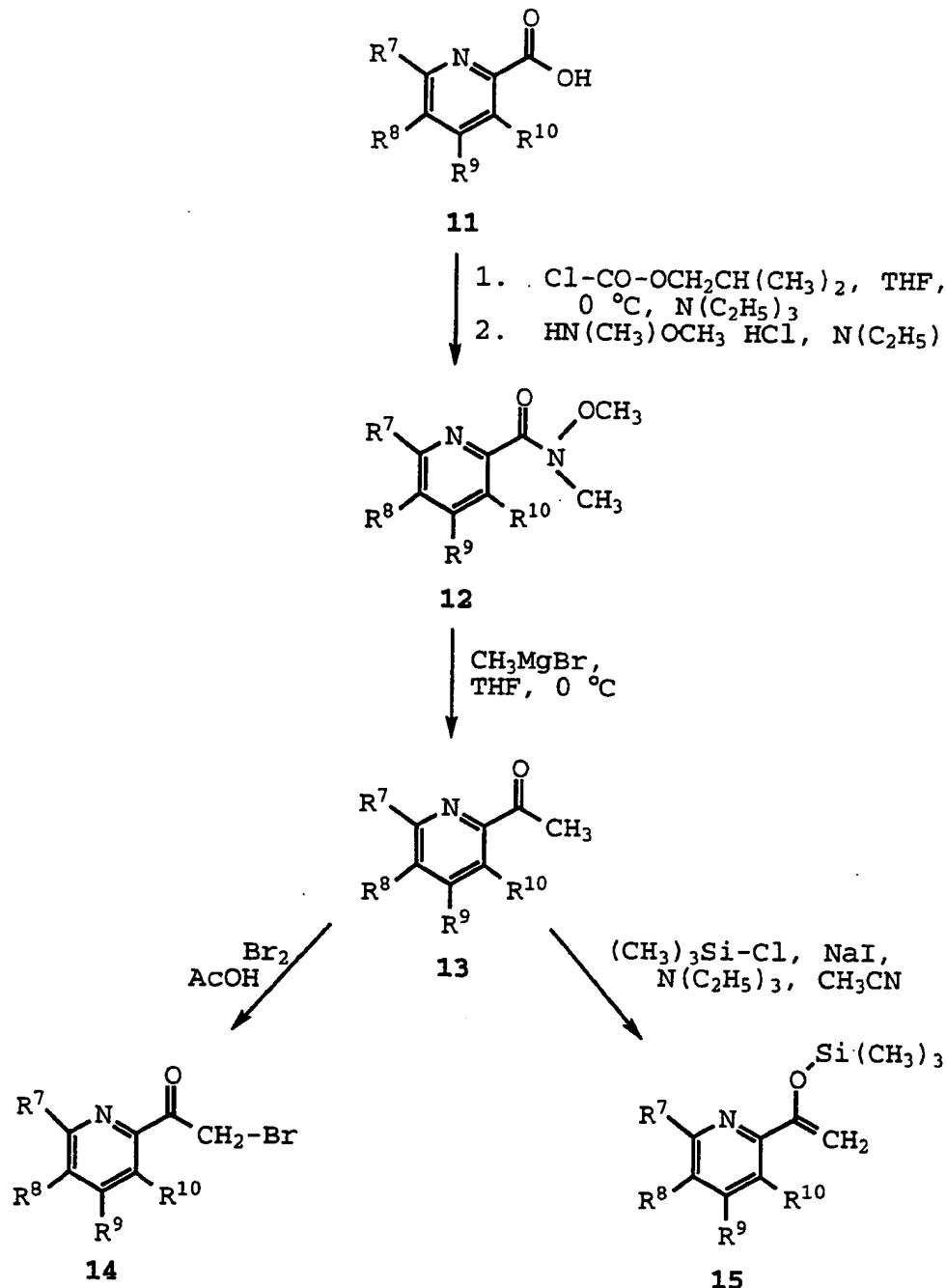
Synthetic Scheme I shows the three step procedures used to prepare the bromoacetophenones **4** and the phenyl silyl enol ethers **5** from commercially available 5 benzoic acids **1**. In step one, a THF solution at 0°C of the benzoic acids **1** and two equivalents of triethylamine are sequentially treated with isobutyl chloroformate and N-hydroxymethyl-N-methylamine hydrochloride to give the Weinreb amides **2** [see: S. Nahm and S. M. Weinreb, 10 Tetrahedron Lett., 21, 3815 (1981)]. In step two, the amides **2** are reacted with methylmagnesium bromide to give the corresponding acetophenones **3**. In step three, the acetophenones **3** are either treated with bromine in acetic acid to give the corresponding bromoacetophenones **4** or 15 chlorotrimethylsilane in acetonitrile in the presence of triethylamine and sodium iodide to give the corresponding phenyl silyl enol ethers **5**.

Scheme II



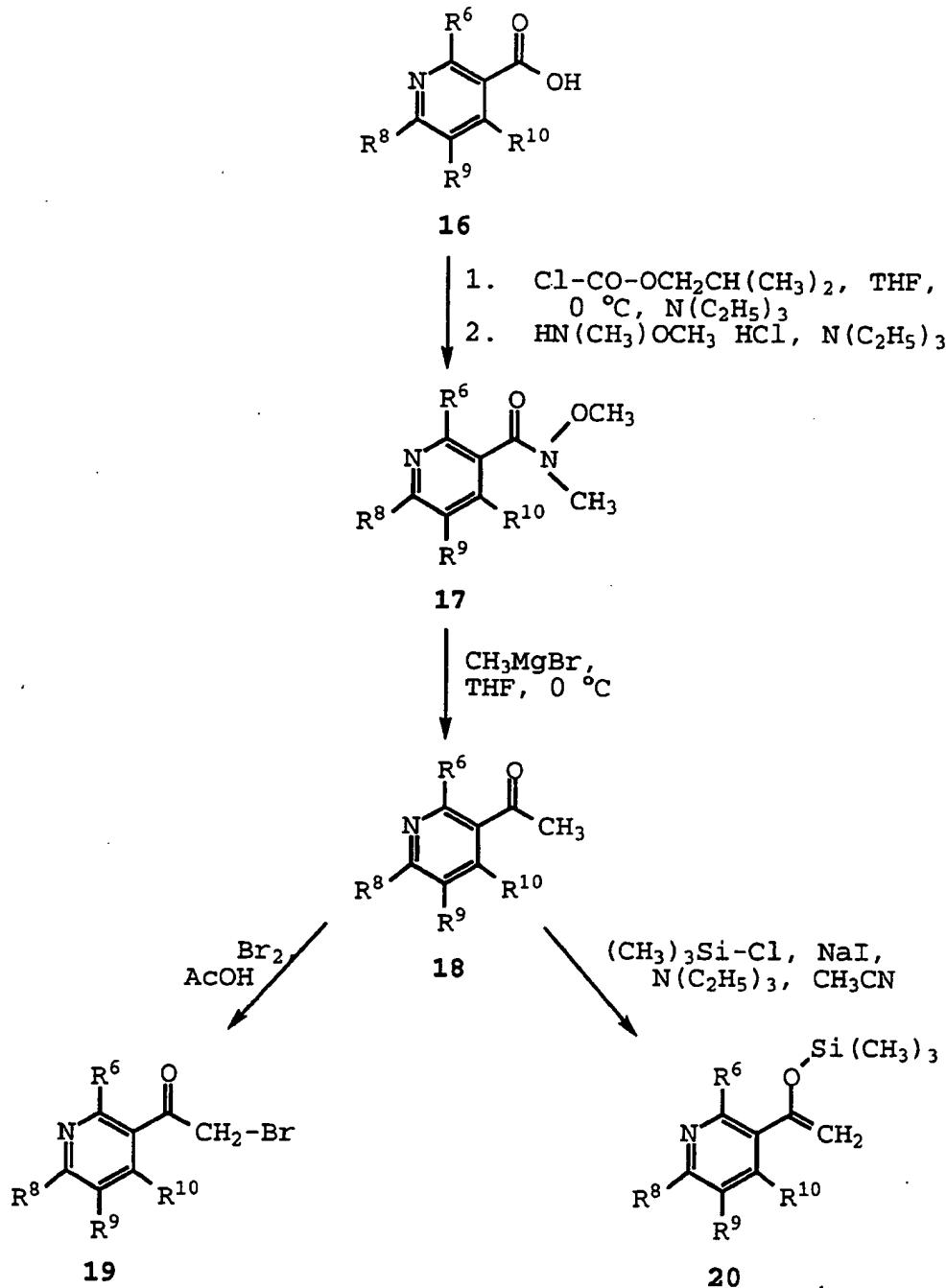
Synthetic Scheme II shows the three step procedures used to prepare the bromoacetophenones **9** and 5 the phenyl silyl enol ethers **10** from commercially

available benzoic acids 6. In step one, a THF solution at 0°C of the benzoic acids 6 and two equivalents of triethylamine are sequentially treated with isobutyl chloroformate and N-hydroxymethyl-N-methylamine 5 hydrochloride to give the Weinreb amides 7. In step two, the amides 7 are reacted with methylmagnesium bromide to give the corresponding acetophenones 8. In step three, the acetophenones 8 are either treated with bromine in acetic acid to give the corresponding bromoacetophenones 9 10 or chlorotrimethylsilane in acetonitrile in the presence of triethylamine and sodium iodide to give the corresponding phenyl silyl enol ethers 10.

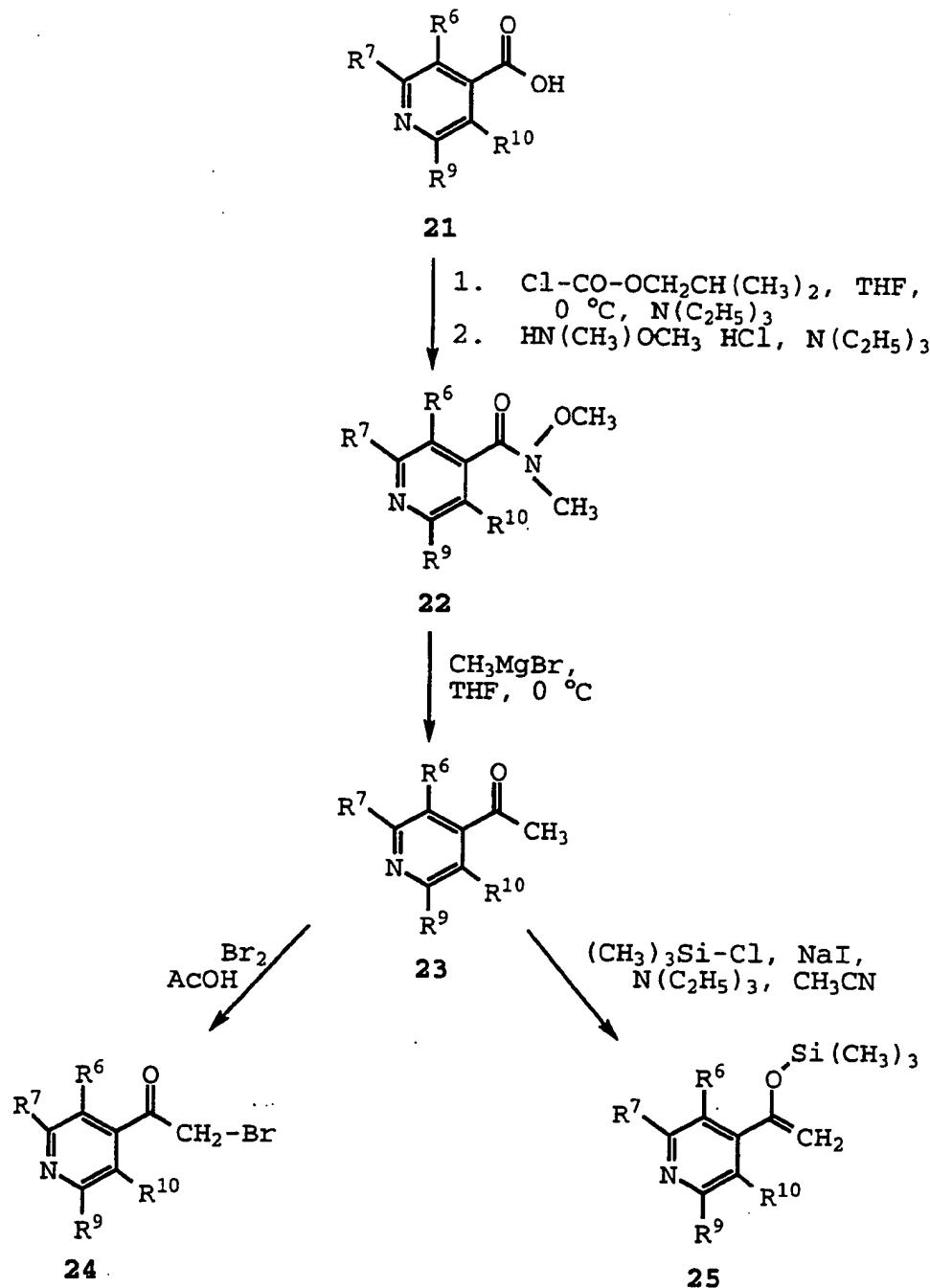
Scheme III

Synthetic Scheme III shows the three step procedures used to prepare the 2-(bromoacetyl)pyridines **14** and the 2-pyridinyl silyl enol ethers **15** from commercially available picolinic acids **11**. In step one, a THF solution at 0°C of the picolinic acids **11** and two equivalents of triethylamine are sequentially treated with isobutyl chloroformate and N-hydroxymethyl-N-methylamine hydrochloride to give the Weinreb amides **12**. In step two, the amides **12** are reacted with methylmagnesium bromide to give the corresponding 2-acetylpyridines **13**. In step three, the 2-acetylpyridines **13** are either treated with bromine in acetic acid to give the corresponding 2-(bromoacetyl)pyridines **14** or chlorotrimethylsilane in acetonitrile in the presence of triethylamine and sodium iodide to give the corresponding 2-pyridinyl silyl enol ethers **15**.

Scheme IV

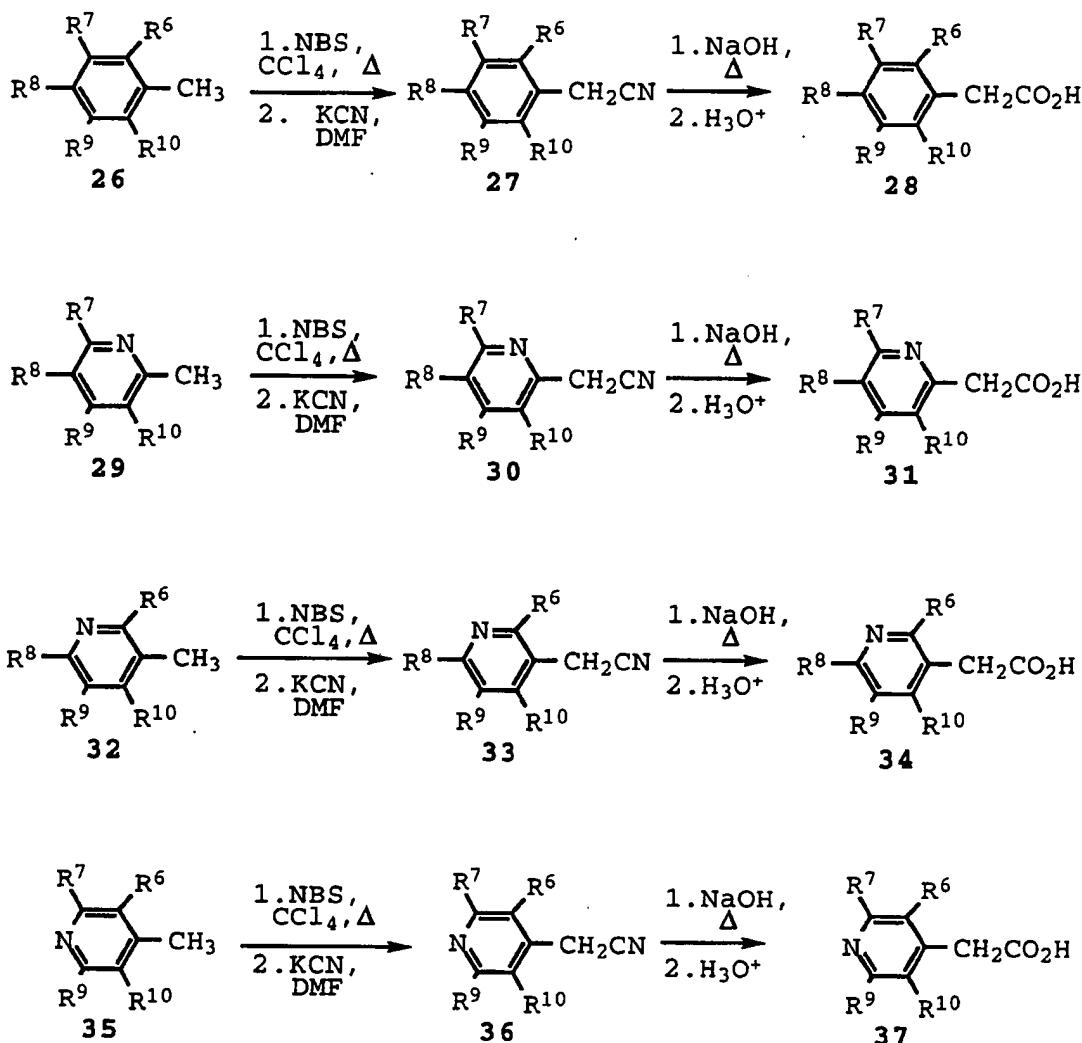


Synthetic Scheme IV shows the three step procedures used to prepare the 3-(bromoacetyl)pyridines **19** and the 3-pyridinyl silyl enol ethers **20** from commercially available nicotinic acids **16**. In step one, a THF solution at 0°C of the nicotinic acids **16** and two equivalents of triethylamine are sequentially treated with isobutyl chloroformate and N-hydroxymethyl-N-methylamine hydrochloride to give the Weinreb amides **17**. In step two, the amides **17** are reacted with methylmagnesium bromide to give the corresponding 3-acetylpyridines **18**. In step three, the 3-acetylpyridines **18** are either treated with bromine in acetic acid to give the corresponding 3-(bromoacetyl)pyridines **19** or chlorotrimethylsilane in acetonitrile in the presence of triethylamine and sodium iodide to give the corresponding 3-pyridinyl silyl enol ethers **20**.

Scheme V

Synthetic Scheme V shows the three step procedures used to prepare the 4-(bromoacetyl)pyridines **24** and the 4-pyridinyl silyl enol ethers **25** from commercially available isonicotinic acids **21**. In step one, a THF solution at 0°C of the isonicotinic acids **21** and two equivalents of triethylamine are sequentially treated with isobutyl chloroformate and N-hydroxymethyl-N-methylamine hydrochloride to give the Weinreb amides **22**. In step two, the amides **22** are reacted with methylmagnesium bromide to give the corresponding 4-acetylpyridines **23**. In step three, the 4-acetylpyridines **23** are either treated with bromine in acetic acid to give the corresponding 4-(bromoacetyl)pyridines **24** or chlorotrimethylsilane in acetonitrile in the presence of triethylamine and sodium iodide to give the corresponding 4-pyridinyl silyl enol ethers **25**.

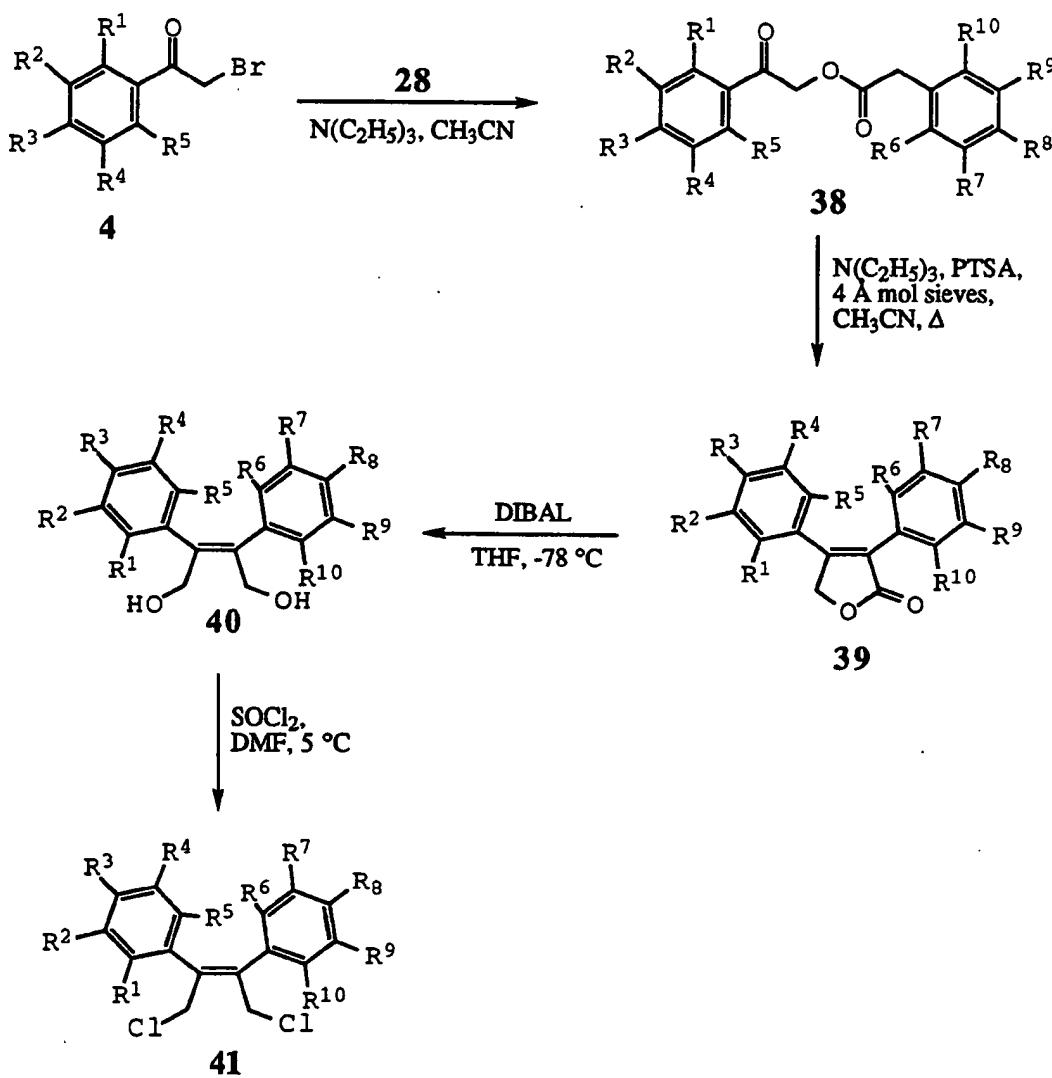
Scheme VI



Synthetic Scheme VI shows the two step procedures which can be used to prepare the phenylacetic acids **28**, 2-pyridinylacetic acids **31**, 3-pyridinylacetic acids **34**, and 4-pyridinylacetic acids **37** from commercially available toluenes **26**, 2-picoline **29**, 3-picoline **32**, and 4-picoline **35**, respectively. In step one, toluenes **26**, 2-picolines **29**, 3-picolines **32**, and 4-picolines **35** are sequentially treated with N-bromosuccinimide (NBS) in carbon tetrachloride at reflux in the presence of a free radical initiator, e.g., 2,2'-azobis(2-

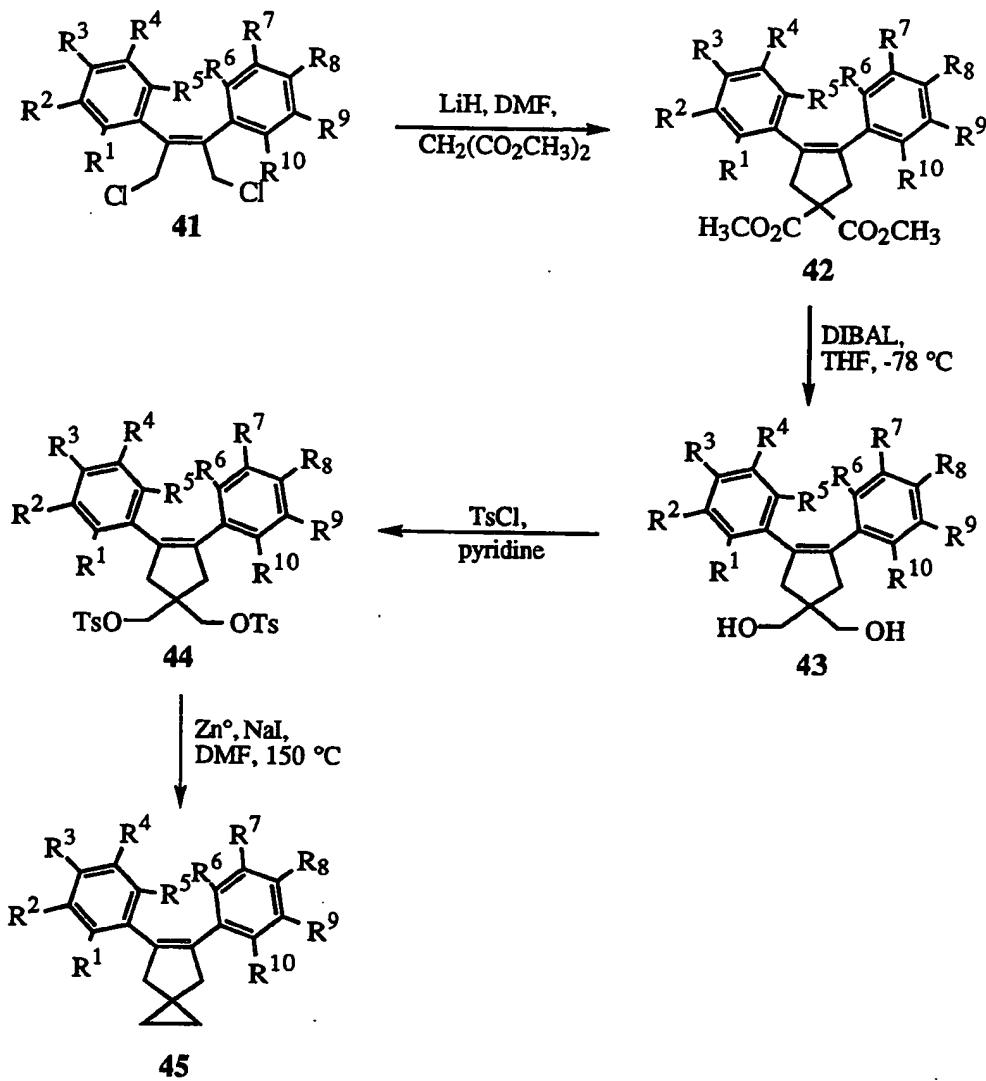
methylpropionitrile) (AIBN), and potassium cyanide in DMF to give the corresponding phenylacetonitriles **27**, 2-pyridinylacetonitriles **30**, 3-pyridinylacetonitriles **33**, and 4-pyridinylacetonitriles **36**, respectively. In step 5 two, phenylacetonitriles **27**, 2-pyridinylacetonitriles **30**, 3-pyridinylacetonitriles **33**, and 4-pyridinylacetonitriles **36** are hydrolyzed with aqueous sodium hydroxide; acidification provides the phenylacetic acids **28**, 2-pyridinylacetic acids **31**, 3-pyridinylacetic acids **34**, and 10 4-pyridinylacetic acids **37**, respectively.

Scheme VII



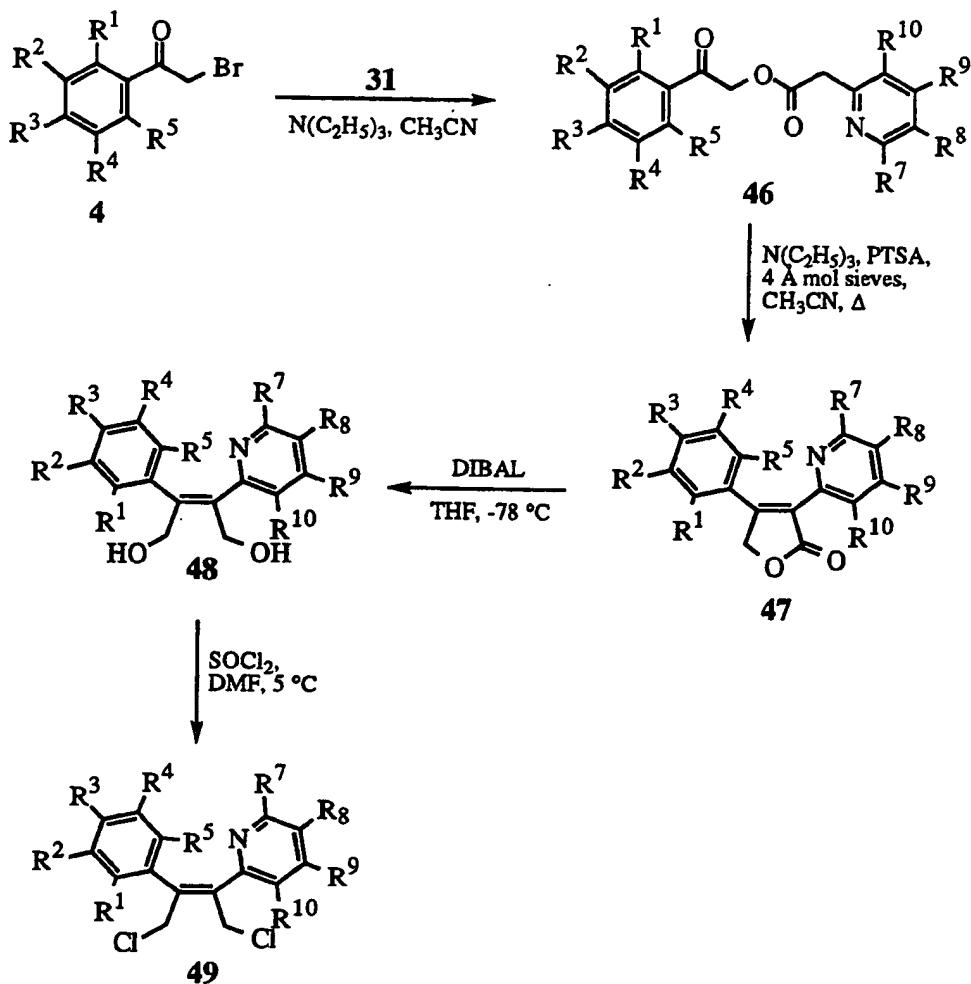
Synthetic Scheme VII shows the four step procedures used to prepare the cis-2,3-diaryl-1,4-dichloro-2-butenes **41** from the bromoacetophenones **4** (prepared in Synthetic Scheme I) and the phenylacetic acids **28** (prepared in Synthetic Scheme VI). In step one, bromoacetophenones **4** are reacted with phenylacetic acids **28** in acetonitrile in the presence of triethylamine to give the corresponding esters **38**. In step two, the esters **38** are cyclized to the corresponding furanones **39** on treatment with *p*-toluenesulfonic acid (PTSA) and triethylamine in the presence of 4 Å molecular sieves in acetonitrile at reflux. In step three, the furanones **39** are reacted with diisobutylaluminum hydride (DIBAL) to give the corresponding cis-diols **40**. In step four, the cis-diols **40** are reacted with thionyl chloride in DMF at 5°C to give the corresponding cis-2,3-diaryl-1,4-dichloro-2-butenes **41**.

Scheme VIII



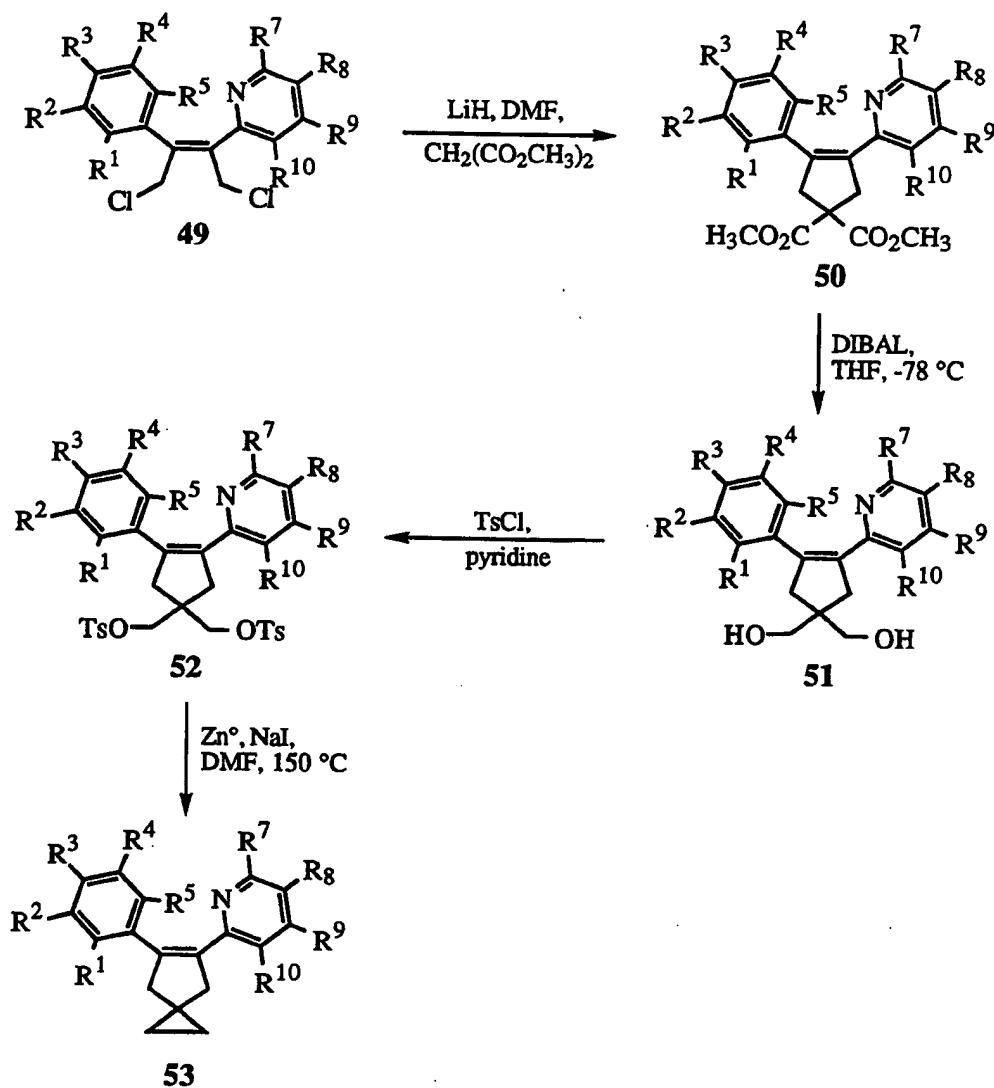
Synthetic Scheme VIII shows the four step procedure used to prepare the 5,6-diarylspiro[2.4]hept-5-enes **45** from the cis-2,3-diaryl-1,4-dichloro-2-butenes **41** (prepared in Synthetic Scheme VII). In step one, the cis-5 2,3-diaryl-1,4-dichloro-2-butenes **41** are reacted with dimethyl malonate in DMF in the presence of two equivalents of lithium hydride to give the corresponding 4,4-dicarbomethoxycyclopentenes **42**. In step two, the 4,4-dicarbomethoxycyclopentenes **42** are reacted with DIBAL in 10 THF to give the corresponding 4,4-di(hydroxymethyl)cyclopentenes **43**. In step three, the 4,4-di(hydroxymethyl)cyclopentenes **43** are reacted with *p*-toluenesulfonyl chloride (TsCl) in pyridine to give the corresponding 4,4-ditosylates **44**. In step four, the 4,4-ditosylates **44** are reacted with metallic zinc and sodium iodide in DMF at 150°C to give the 5,6-diarylspiro[2.4]hept-5-ene antiinflammatory agents **45** of this invention.

Scheme IX



Synthetic Scheme IX shows the four step procedure used to prepare the *cis*-2-(2-pyridinyl)-3-aryl-1,4-dichloro-2-butenes **49** from the bromoacetophenones **4** (prepared in Synthetic Scheme I) and the 2-pyridinylacetic acids **31** (prepared in Synthetic Scheme VI). In step one, bromoacetophenones **4** are reacted with 2-pyridinylacetic acids **31** in acetonitrile in the presence of triethylamine to give the corresponding esters **46**. In step two, the esters **46** are cyclized to the corresponding furanones **47** on treatment with *p*-toluenesulfonic acid (PTSA) and triethylamine in the presence of 4 Å molecular sieves in acetonitrile at reflux. In step three, the furanones **47** are reacted with diisobutylaluminum hydride (DIBAL) to give the corresponding *cis*-diols **48**. In step four, the *cis*-diols **48** are reacted with thionyl chloride in DMF at 5°C to give the corresponding *cis*-2-(2-pyridinyl)-3-aryl-1,4-dichloro-2-butenes **49**.

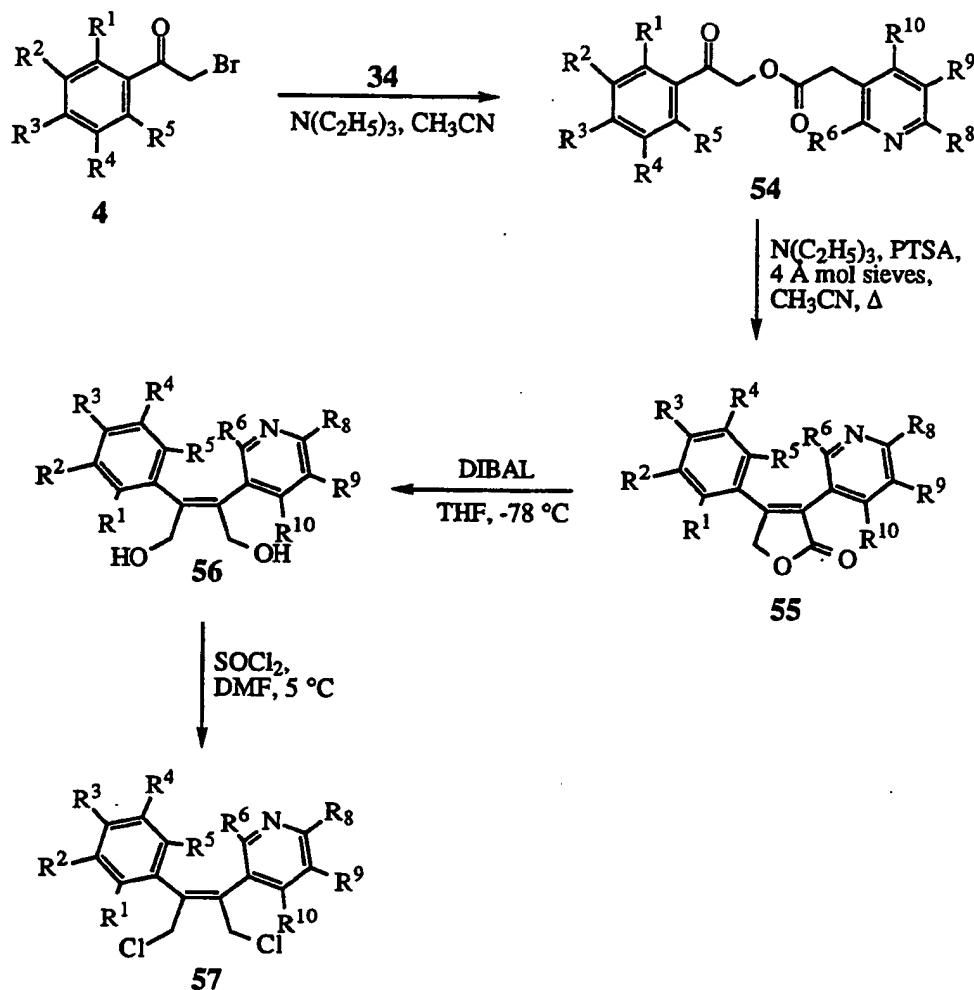
Scheme X



Synthetic Scheme X shows the four step procedure used to prepare the 5-(2-pyridinyl)-6-arylspiro[2.4]hept-5-enes **53** from the cis-2-(2-pyridinyl)-3-aryl-1,4-dichloro-2-butenes **49** (prepared in Synthetic Scheme IX).

- 5 In step one, the cis-2-(2-pyridinyl)-3-aryl-1,4-dichloro-2-butenes **49** are reacted with dimethyl malonate in DMF in the presence of two equivalents of lithium hydride to give the corresponding 4,4-dicarbomethoxycyclopentenes **50**. In step two, the 4,4-dicarbomethoxycyclopentenes **50** are
- 10 reacted with DIBAL in THF to give the corresponding 4,4-di(hydroxymethyl)cyclopentenes **51**. In step three, the 4,4-di(hydroxymethyl)cyclopentenes **51** are reacted with *p*-toluenesulfonyl chloride (TsCl) in pyridine to give the corresponding 4,4-ditosylates **52**. In step four, the 4,4-ditosylates **52** are reacted with metallic zinc and sodium iodide in DMF at 150°C to give the 5-(2-pyridinyl)-6-arylspiro[2.4]hept-5-ene antiinflammatory agents **53** of this invention.

Scheme XI

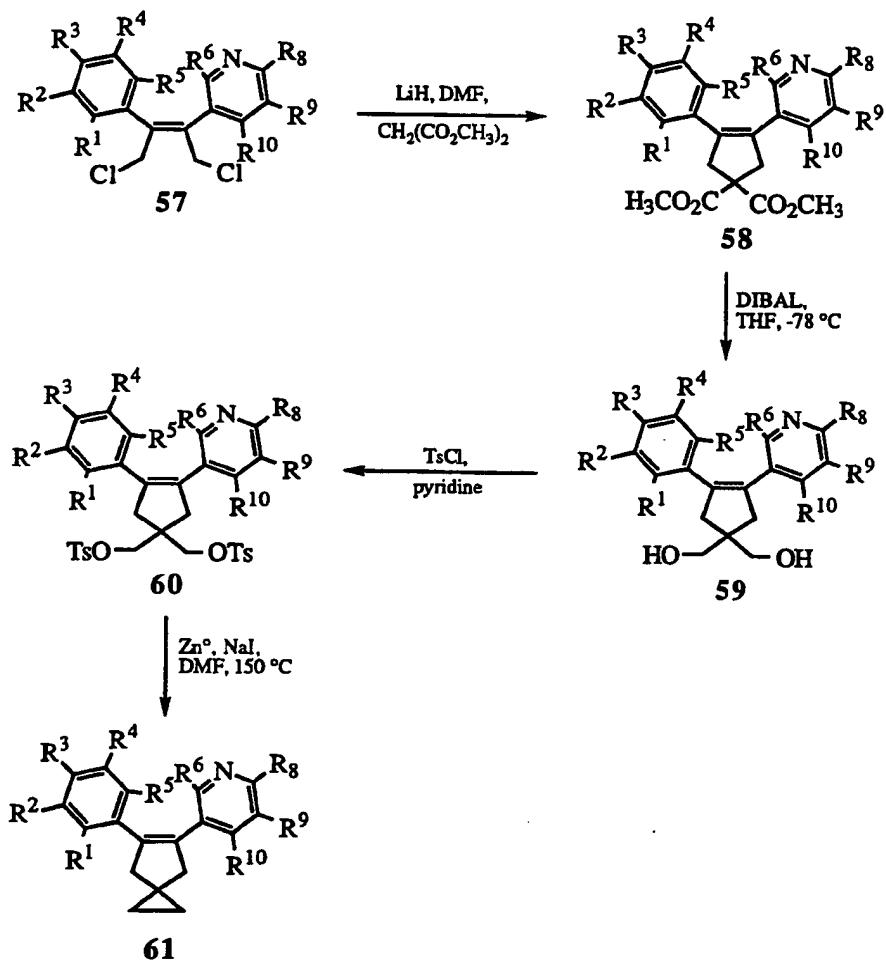


Synthetic Scheme XI shows the four step procedure used to prepare the cis-2-(3-pyridinyl)-3-aryl-1,4-dichloro-2-butenes 57 from the bromoacetophenones 4 (prepared in Synthetic Scheme I) and the 3-pyridinylacetic acids 34 (prepared in Synthetic Scheme VI). In step one, bromoacetophenones 4 are reacted with 3-pyridinylacetic acids 34 in acetonitrile in the presence of triethylamine to give the corresponding esters 54. In step two, the esters 54 are cyclized to the corresponding furanones 55 on treatment with *p*-toluenesulfonic acid (PTSA) and triethylamine in the presence of 4 Å molecular sieves in

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acetonitrile at reflux. In step three, the furanones 55 are reacted with diisobutylaluminum hydride (DIBAL) to give the corresponding cis-diols 56. In step four, the cis-diols 56 are reacted with thionyl chloride in DMF at 5°C to give the corresponding cis-2-(3-pyridinyl)-3-aryl-1,4-dichloro-2-butenes 57.

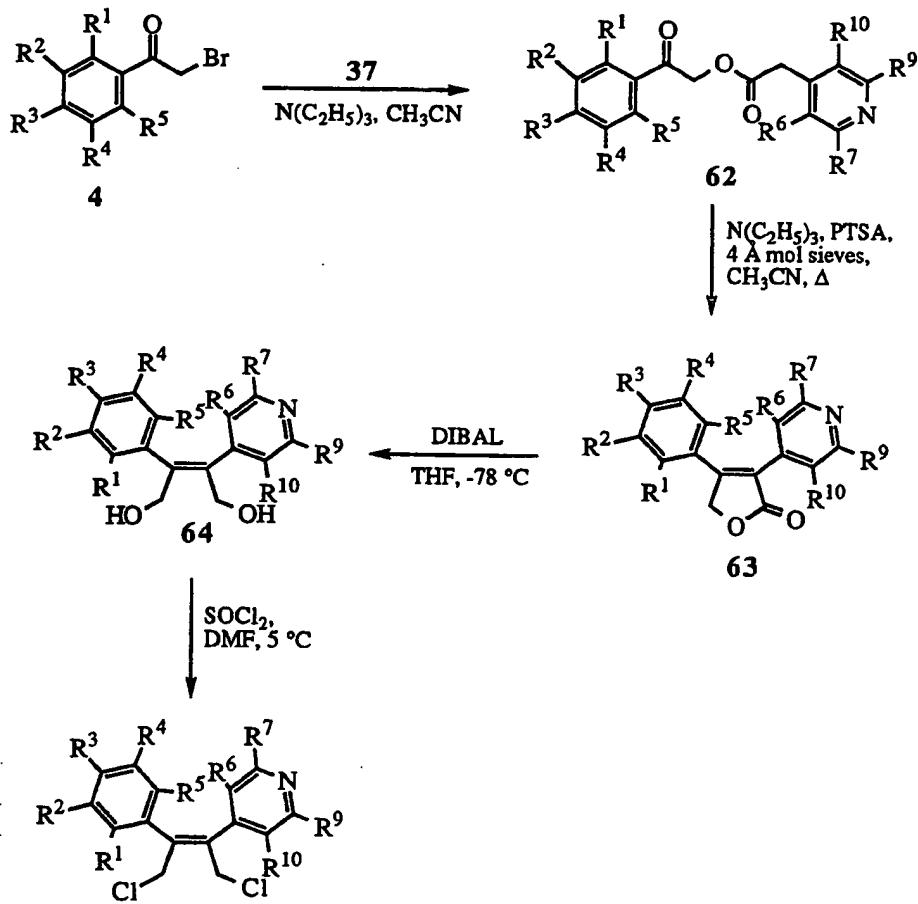
Scheme XIII



10 Synthetic Scheme XII shows the four step procedure used to prepare the 5-(3-pyridinyl)-6-arylspiro[2.4]hept-5-enes **61** from the *cis*-2-(3-pyridinyl)-3-aryl-1,4-dichloro-2-butenes **57** (prepared in Synthetic Scheme XI). In step one, the *cis*-2-(3-pyridinyl)-3-aryl-1,4-dichloro-2-butenes **57** are reacted

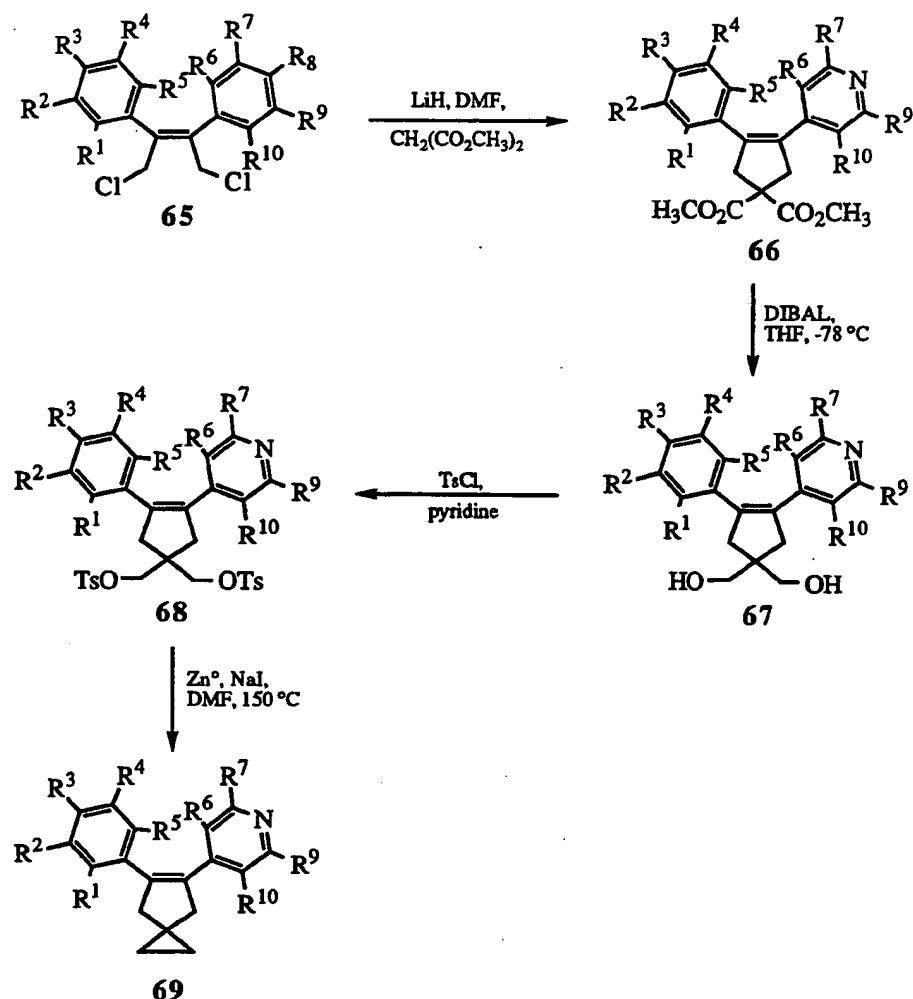
with dimethyl malonate in DMF in the presence of two equivalents of lithium hydride to give the corresponding 4,4-dicarbomethoxycyclopentenes 58. In step two, the 4,4-dicarbomethoxycyclopentenes 58 are reacted with DIBAL in THF to give the corresponding 4,4-di(hydroxymethyl)cyclopentenes 59. In step three, the 4,4-di(hydroxymethyl)cyclopentenes 59 are reacted with *p*-toluenesulfonyl chloride (TsCl) in pyridine to give the corresponding 4,4-ditosylates 60. In step four, the 4,4-ditosylates 60 are reacted with metallic zinc and sodium iodide in DMF at 150°C to give the 5-(3-pyridinyl)-6-arylspiro[2.4]hept-5-ene antiinflammatory agents 61 of this invention.

Scheme XIII



Synthetic Scheme XIII shows the four step procedure used to prepare the cis-2-(4-pyridinyl)-3-aryl-1,4-dichloro-2-butenes 65 from the bromoacetophenones 4 (prepared in Synthetic Scheme I) and the 4-pyridinylacetic acids 37 (prepared in Synthetic Scheme VI). In step one, bromoacetophenones 4 are reacted with 4-pyridinylacetic acids 37 in acetonitrile in the presence of triethylamine to give the corresponding esters 62. In step two, the esters 62 are cyclized to the corresponding furanones 63 on treatment with *p*-toluenesulfonic acid (PTSA) and triethylamine in the presence of 4 Å molecular sieves in acetonitrile at reflux. In step three, the furanones 63 are reacted with diisobutylaluminum hydride (DIBAL) to give the corresponding cis-diols 64. In step four, the cis-diols 64 are reacted with thionyl chloride in DMF at 5°C to give the corresponding cis-2-(4-pyridinyl)-3-aryl-1,4-dichloro-2-butenes 65.

Scheme XIV

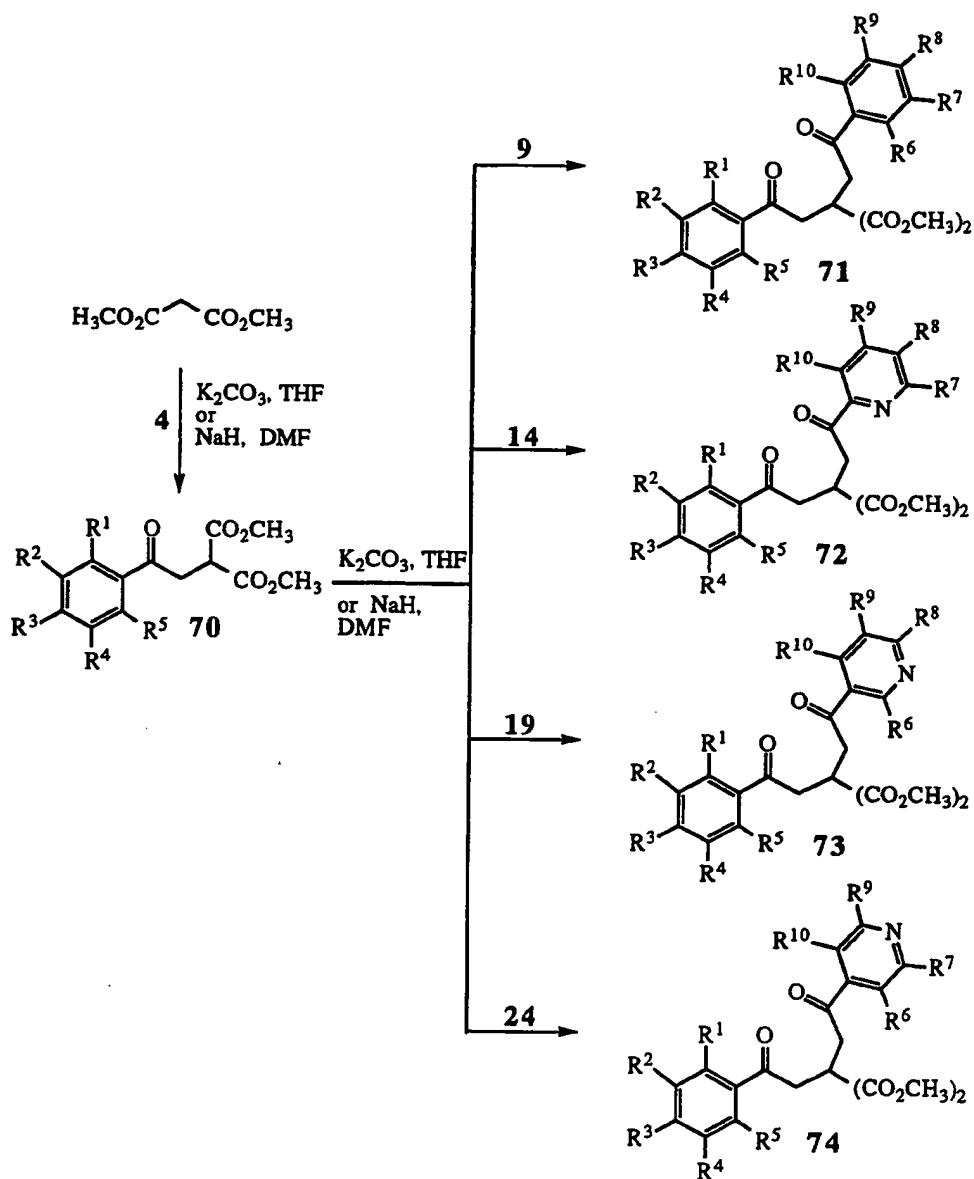


Synthetic Scheme XIV shows the four step procedure used to prepare the 5-(4-pyridinyl)-6-arylspiro[2.4]hept-5-enes 69 from the cis-2-(4-pyridinyl)-3-aryl-1,4-dichloro-2-butenes 65 (prepared in Synthetic Scheme XIII). In step one, the cis-2-(4-pyridinyl)-3-aryl-1,4-dichloro-2-butenes 65 are reacted with dimethyl malonate in DMF in the presence of two equivalents of lithium hydride to give the corresponding 4,4-dicarbomethoxycyclopentenes 66. In step two, the 4,4-dicarbomethoxycyclopentenes 66 are reacted with DIBAL in THF to give the corresponding 4,4-dihydroxy-4,4-dicarbomethoxycyclopentenes 67. In step three, the 4,4-dihydroxy-4,4-dicarbomethoxycyclopentenes 67 are reacted with TsCl in pyridine to give the corresponding 4,4-ditosyloxy-4,4-dicarbomethoxycyclopentenes 68. In step four, the 4,4-ditosyloxy-4,4-dicarbomethoxycyclopentenes 68 are reacted with Zn°, NaI, and DMF at 150 °C to give the corresponding 5-(4-pyridinyl)-6-arylspiro[2.4]hept-5-enes 69.

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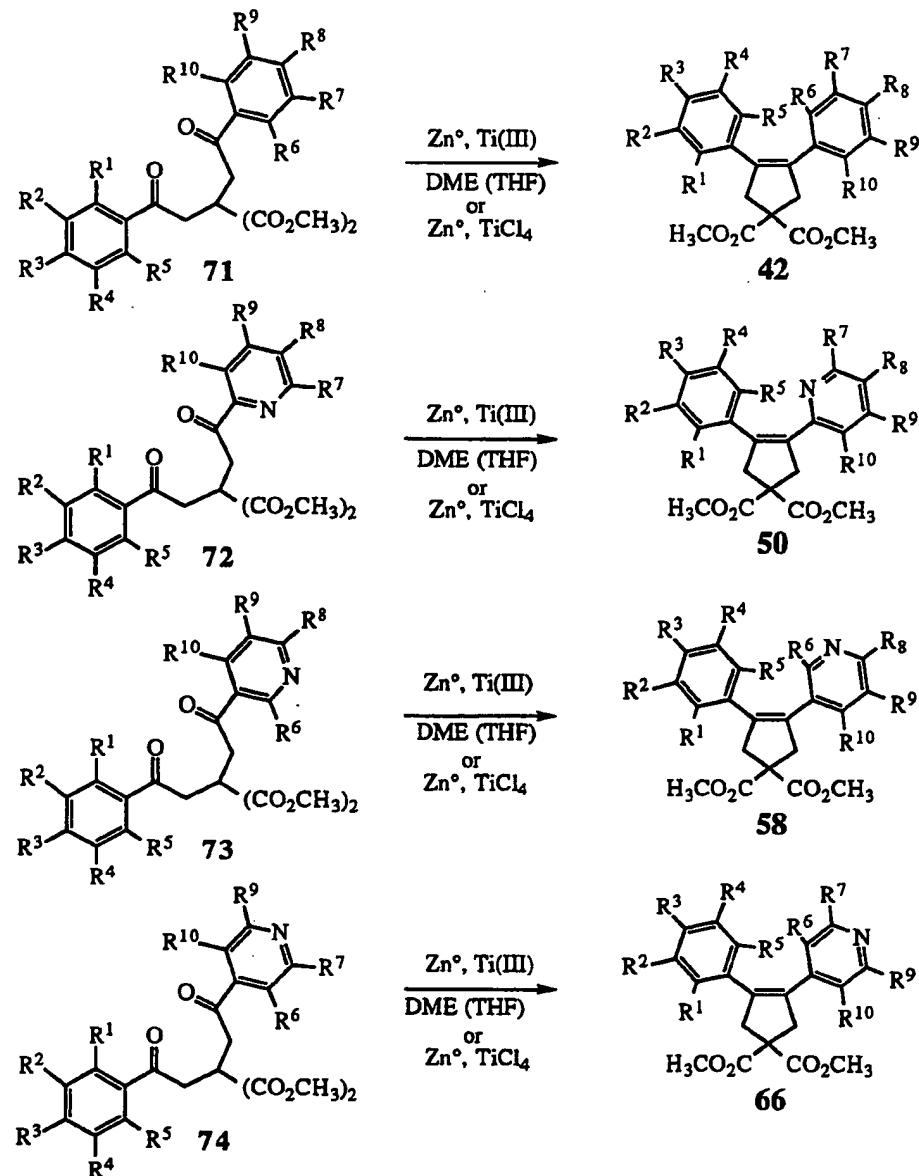
di(hydroxymethyl)cyclopentenes **67**. In step three, the 4,4-di(hydroxymethyl)cyclopentenes **67** are reacted with *p*-toluenesulfonyl chloride (TsCl) in pyridine to give the corresponding 4,4-ditosylates **68**. In step four, the 4,4-ditosylates **68** are reacted with metallic zinc and sodium iodide in DMF at 150°C to give the 5-(4-pyridinyl)-6-arylspiro[2.4]hept-5-ene antiinflammatory agents **69** of this invention.

Scheme XV



Synthetic Scheme XV shows the two step procedures which can be used to prepare the dialkylated compounds 71, 72, 73, and 74. In step one, dimethyl malonate and potassium carbonate in THF (or sodium hydride in DMF) is reacted with the bromoacetophenones 4 (prepared in Synthetic Scheme I) to give the monoalkylated compounds 70. In step two, the monoalkylated compounds 70 are reacted with the bromoacetophenones 9 (prepared in Synthetic Scheme II), the 2-(bromoacetyl)pyridines 14 (prepared in Synthetic Scheme III), the 3-(bromoacetyl)pyridines 19 (prepared in Synthetic Scheme IV), and the 4-(bromoacetyl)pyridines 24 (prepared in Synthetic Scheme V) in THF in the presence of potassium carbonate (or sodium hydride in DMF) to give the 15 dialkylated compounds 71, 72, 73, and 74, respectively.

Scheme XVI



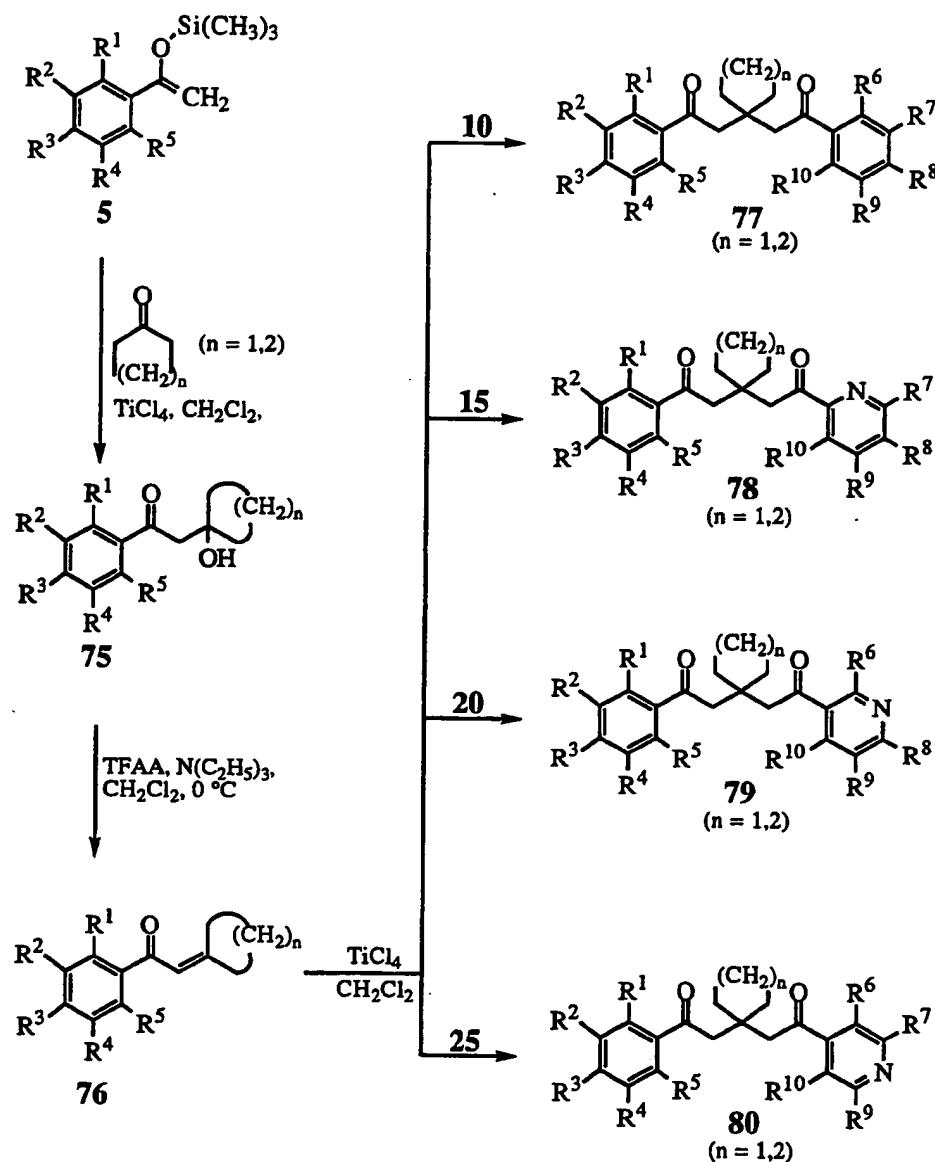
Synthetic Scheme XVI shows alternative procedures which can be used to prepare the 4,4-dicarbomethoxycyclopentenes 42, 50, 58, and 66 from the dialkylated compounds 71, 72, 73, and 74, respectively (prepared in Synthetic Scheme XV). The dialkylated compounds 71, 72, 73, and 74 are reacted with metallic zinc and titanium(III) chloride [or titanium(IV) chloride] in DME (or THF) to give the 4,4-

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dicarbomethoxycyclopentenes 42, 50, 58, and 66, respectively. By procedures outlined in Schemes VIII, X, XII, and XIV, 42, 50, 58, and 66 can be converted to the 5,6-diarylspiro[2.4]hept-5-ene antiinflammatory agents
5 45, 5-(2-pyridinyl)-6-arylspiro[2.4]hept-5-ene antiinflammatory agents 53, 5-(3-pyridinyl)-6-arylspiro[2.4]hept-5-ene antiinflammatory agents 61, and 5-(4-pyridinyl)-6-arylspiro[2.4]hept-5-ene antiinflammatory agents 69, respectively, of this
10 invention.

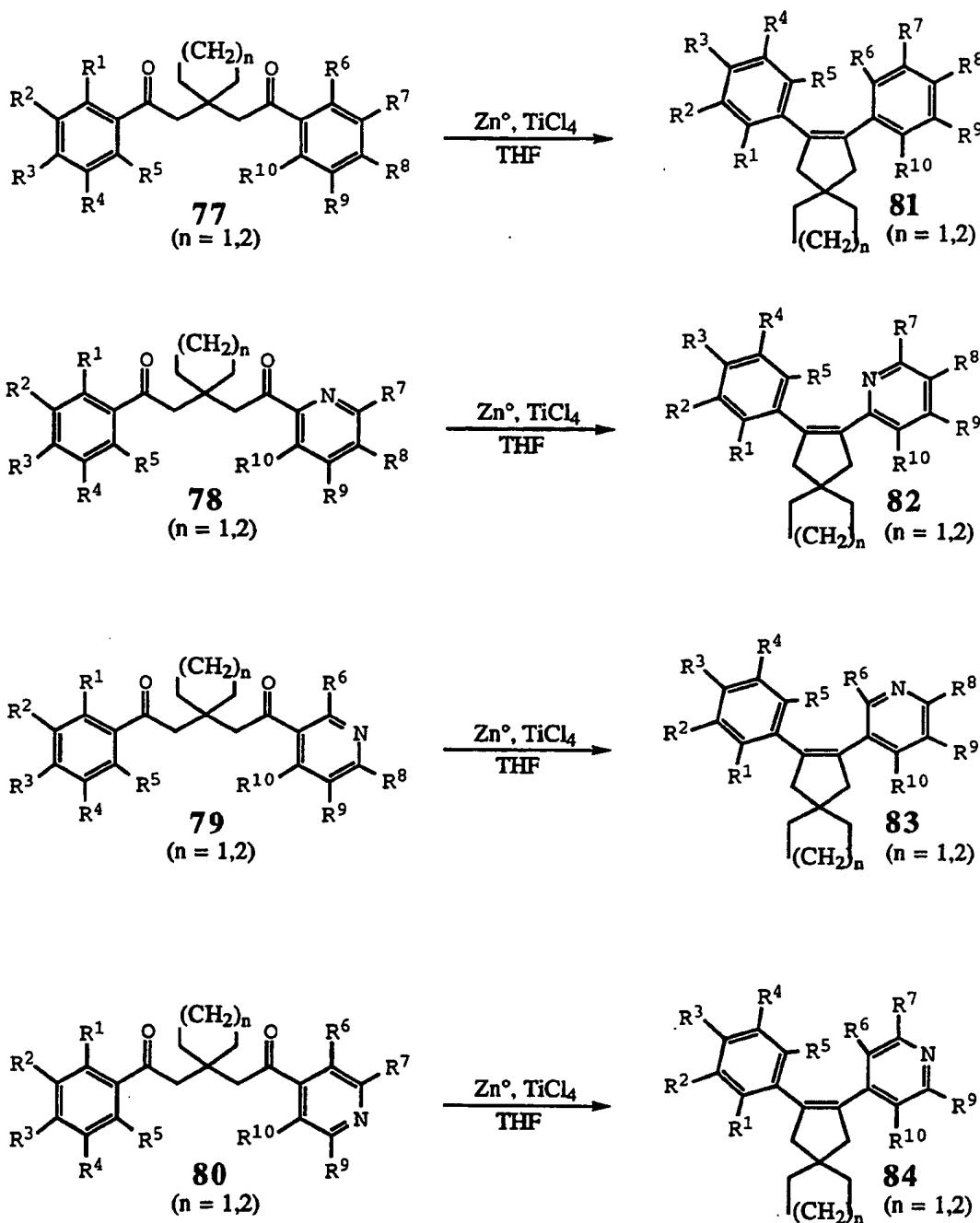
Scheme XVII



Synthetic Scheme XVII shows the three step procedures used to prepare the cycloalkyldiketones 77, 78, 79 and 80 from the phenyl silyl enol ethers 5 (prepared in Synthetic Scheme I) and cycloalkanones (n = 1, 2). In step one, the silyl enol ethers 5 are reacted with cycloalkanones (n = 1, 2) in methylene chloride in the presence of titanium(IV) chloride to give the

corresponding cycloalkanols 75. In step two, the cycloalkanols 75 are dehydrated with trifluoroacetic anhydride and triethylamine in methylene chloride at 0°C to give the corresponding conjugated exocyclic olefins 76. In step three, the olefins 76 are reacted with the phenyl silyl enol ethers 10 (prepared in Synthetic Scheme II), 2-pyridinyl silyl enol ethers 15 (prepared in Synthetic Scheme III), 3-pyridinyl silyl enol ethers 20 (prepared in Synthetic Scheme IV), and 4-pyridinyl silyl enol ethers 25 (prepared in Synthetic Scheme V) to give the cycloalkyldiketones ($n = 1,2$) 77, 78, 79 and 80, respectively.

Scheme XVIII

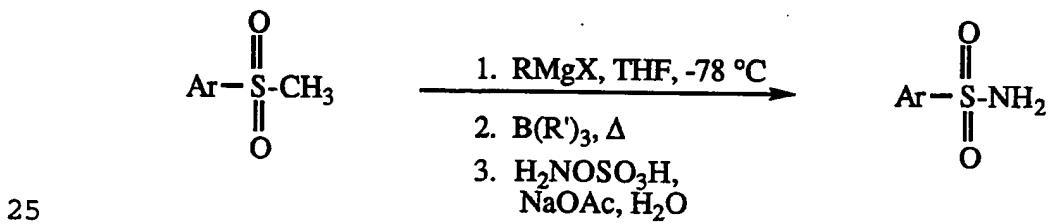


Synthetic Scheme XVIII shows the procedures

- used to prepare 6,7-diarylspiro[3.4]oct-6-enes **81** ($n = 1$) and 2,3-diarylspiro[4.4]non-2-enes **81** ($n = 2$), 6-(2-

pyridinyl)-7-arylspiro[3.4]oct-6-enes **82** (*n* = 1) and 2-(2-pyridinyl)-3-arylspiro[4.4]non-2-enes **82** (*n* = 2), 6-(3-pyridinyl)-7-arylspiro[3.4]oct-6-enes **83** (*n* = 1) and 2-(3-pyridinyl)-3-arylspiro[4.4]non-2-enes **83** (*n* = 2),
 5 and 6-(4-pyridinyl)-7-arylspiro[3.4]oct-6-enes **84** (*n* = 1) and 2-(4-pyridinyl)-3-arylspiro[4.4]non-2-enes **84** (*n* = 2) from cycloalkyldiketones (*n* = 1,2) **77**, **78**, **79** and **80**, respectively (prepared in Synthetic Scheme XVII). The cycloalkyldiketones (*n* = 1,2) **77**, **78**, **79** and **80** are
 10 reacted metallic zinc and titanium(IV) chloride in THF to give the 6,7-diarylspiro[3.4]oct-6-ene antiinflammatory agents **81** (*n* = 1) and 2,3-diarylspiro[4.4]non-2-ene antiinflammatory agents **81** (*n* = 2), 6-(2-pyridinyl)-7-arylspiro[3.4]oct-6-ene antiinflammatory agents **82** (*n* = 1) and 2-(2-pyridinyl)-3-arylspiro[4.4]non-2-ene
 15 antiinflammatory agents **82** (*n* = 2), the 6-(3-pyridinyl)-7-arylspiro[3.4]oct-6-ene antiinflammatory agents **83** (*n* = 1) and 2-(3-pyridinyl)-3-arylspiro[4.4]non-2-ene antiinflammatory agents **83** (*n* = 2), and the 6-(4-pyridinyl)-7-arylspiro[3.4]oct-6-ene antiinflammatory agents **84** (*n* = 1) and 2-(4-pyridinyl)-3-arylspiro[4.4]non-2-ene antiinflammatory agents **84** (*n* = 2), respectively, of this invention.

Scheme XIX



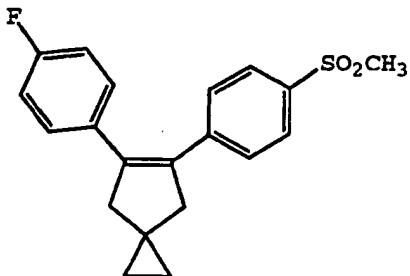
Synthetic Scheme XIX shows the three step procedure used to prepare sulfonamide antiinflammatory

agents from their corresponding methyl sulfones. In step one, a THF solution of the methyl sulfones at -78°C is treated with a grignard reagent (RMgX), e.g., methylmagnesium bromide, propylmagnesium chloride, etc., or an alkylolithium reagent, e.g., methyllithium, n-butyllithium, etc. In step two, the anions generated in step one is treated with an organoborane, e.g., triethylborane, tributylborane, etc., at -78°C then allowed to warm to ambient temperature prior to stirring at reflux. In step three, an aqueous solution of sodium acetate and hydroxyamine-O-sulfonic acid is added to provide the corresponding sulfonamide antiinflammatory agents of this invention.

15 The following examples contain detailed descriptions of the methods of preparation of compounds of Formula I-VI. These detailed descriptions fall within the scope, and serve to exemplify, the above described General Synthetic Procedures which form part of the invention. These detailed descriptions are presented for illustrative purposes only and are not intended as a restriction on the scope of the invention. All parts are by weight and temperatures are in Degrees centigrade unless otherwise indicated.

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Example 1



30 5-(4-Fluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Step 1: Preparation of 4-(methylthio)acetophenone

To a stirred solution of 50 g (340 mmol) of 4-(methylthio)benzonitrile in 2 L of THF at -78°C under an atmosphere of nitrogen was added 282 mL (390 mmol) of methyllithium (1.4 M in diethyl ether) over a period of 5 ten minutes. The solution was stirred at -78°C for one hour, and then the dry ice bath was removed. After five hours, 100 mL of water followed by 200 mL of 3N hydrochloric acid were added to the reaction mixture and it was stirred overnight. Concentration in vacuo gave a 10 residue which was partitioned between ethyl acetate and water. The water layer was extracted with three portions of ethyl acetate and the combined ethyl acetate layers were dried (MgSO_4). Concentration in vacuo gave 58 g of crude (4-methylthio)acetophenone as a solid: NMR (CDCl_3) δ 15 2.52 (s, 3H), 2.57 (s, 3H), 7.26 (d, $J = 9$ Hz, 2H), 7.87 (d, $J = 9$ Hz, 2H).

Step 2: Preparation of 4-(methylsulfonyl)acetophenone

20 To a solution of 11.73 g (71.1 mmol) of 4-(methylthio)acetophenone (prepared in Step 1) in 500 mL of methylene chloride at ambient temperature was added 61.14 g (177 mmol) of *m*-chloroperoxybenzoic acid (50%) (MCPBA) in portions over 20 minutes. The reaction was 25 stirred for two hours, quenched slowly with aqueous sodium bisulfite, washed with three 100 mL portions of saturated sodium bicarbonate, dried (MgSO_4), and concentrated in vacuo to give 11.91 g (91%) of (4-methylsulfonyl)acetophenone as a colorless solid: NMR 30 (CDCl_3) δ 2.67 (s, 3H), 3.08 (s, 3H), 8.06 (d, $J = 9$ Hz, 2H), 8.14 (d, $J = 9$ Hz, 2H).

Step 3: Preparation of 2-bromo-4'-(methylsulfonyl)acetophenone

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To a stirred solution of 11.91 g (60.5 mmol) of 4-(methylsulfonyl)acetophenone (prepared in Step 2) in

133 mL of glacial acetic acid and 0.11 mL of hydrochloric acid at ambient temperature was added a solution of 8.22 g (51.4 mmol) of bromine in 9.3 mL of glacial acetic acid over a period of three hours. The reaction mixture was
5 diluted with 500 mL of water and extracted with chloroform. The combined extracts were dried (MgSO_4) and concentrated in vacuo to give 15.7 g of crude 2-bromo-
(4'-methylsulfonyl)acetophenone as a solid: NMR (CDCl_3) δ 3.10 (s, 3H), 4.45 (s, 2H), 8.08 (d, $J = 9$ Hz, 2H), 8.17
10 (d, $J = 9$ Hz, 2H).

Step 4: Preparation of 2-(4-fluorophenyl)-1-[2-[4-(methylsulfonyl)phenyl]-2-oxoethoxy]ethanone

15 To a stirred solution of 4.45 g (28.9 mmol) of 4-fluorophenylacetic acid in 3.26 g (31.8 mmol) of triethylamine and 275 mL of acetonitrile was added 8.9 g (28.9 mmol) of 2-bromo-4'-(methylsulfonyl)acetophenone (prepared in Step 3) at ambient temperature. The
20 reaction mixture was stirred for 30 minutes, concentrated in vacuo, and partitioned between ethyl acetate and water. The organic phase was dried (MgSO_4) and concentrated in vacuo. Purification by silica gel chromatography with ethyl acetate/hexane (1:1) gave 6.87
25 g (68%) of 2-(4-fluorophenyl)-1-[2-[4-(methylsulfonyl)phenyl]-2-oxoethoxy]ethanone as a colorless solid: NMR (CDCl_3) δ 3.08 (s, 3H), 3.79 (s, 2H), 5.35 (s, 2H), 7.06 (s, t, $J = 9$ Hz, 2H), 7.32 (dd, $J = 6$ and 9 Hz, 2H), 8.06 (s, 4H).

30

Step 5: Preparation of 3-(4-fluorophenyl)-4-[4-(methylsulfonyl)phenyl]-5H-furan-2-one

Under nitrogen, 4.10 g (11.7 mmol) of 2-(4-fluorophenyl)-1-[2-[4-(methylsulfonyl)phenyl]-2-oxoethoxy]ethanone (prepared in Step 4), 6.52 mL (46.8 mmol) of triethylamine, 4.89 g (25.7 mmol) of p-

toluenesulfonic acid, and 12 g of 4Å molecular sieves were added to 117 mL of acetonitrile and stirred at reflux for 16 hours. The reaction mixture was concentrated in vacuo and the residue partitioned between 5 methylene chloride and water. The methylene chloride layer was dried ($MgSO_4$) and reconcentrated in vacuo. Recrystallization from hexane/ethyl acetate (2:1) gave 3.65 g (94%) of 3-(4-fluorophenyl)-4-[(4-methylsulfonyl)phenyl]-5H-furan-2-one as a solid: mp 166-10 167°C; NMR ($CDCl_3$) δ 3.08 (s, 3H), 5.19 (s, 2H), 7.10 (t, J = 9 Hz, 2H), 7.42 (dd, J = 6 and 9 Hz, 2H), 7.52 (d, J = 9 Hz, 2H), 7.97 (d, J = 9 Hz, 2H). HRMS Calc'd for $C_{17}H_{13}FO_4S$: 332.0519. Found: 332.0501. Anal. Calc'd for $C_{17}H_{13}FO_4S$: C, 61.44; H, 3.94; O, 19.26. Found: C, 61.11; 15 H, 4.06; O, 19.32.

Step 6: Preparation of 2-(4-fluorophenyl)-3-[(4-methylsulfonyl)phenyl]-1,4-dihydroxy-2-butene

20 To a solution of 3.08 g (9.28 mmol) of 3-(4-fluorophenyl)-4-[(4-methylsulfonyl)phenyl]-5H-furan-2-one (prepared in Step 5) in 93 mL of tetrahydrofuran (THF) at -78°C under an atmosphere of nitrogen was added 20 mL (30 mmol) of diisobutylaluminum hydride (DIBAL) (1.5 M in THF) over a 10 minute period. The solution was stirred at -78°C for 20 minutes, allowed to warm to ambient temperature, and stirred overnight. An additional 15 mL (22 mmol) aliquot of DIBAL was added and stirring was continued for 2 hours. The reaction was cooled to -78°C, 25 treated dropwise with 25 mL of acetone, warmed to room temperature, and slowly treated with 25 mL of water. The mixture was stirred for 30 minutes prior to the careful addition of 35 mL of 1.2 N sodium hydroxide. The mixture was extracted with ethyl acetate, washed with 1 N 30 hydrochloric acid followed by brine, dried ($MgSO_4$), and concentrated in vacuo to give 3.8 g of crude 2-(4-fluorophenyl)-3-[(4-methylsulfonyl)phenyl]-1,4-dihydroxy- 35

2-butene as a colorless oil: NMR (CDCl_3) δ 2.98 (s, 3H), 4.60 (d, $J = 6$ Hz, 4H), 6.8 (t, $J = 9$ Hz, 2H), 6.94-7.02 (m, 2H), 7.22 (d, $J = 9$ Hz, 2H), 7.65 (d, $J = 9$ Hz, 2H).

5 Step 7: Preparation of 2-(4-fluorophenyl)-3-[(4-methylsulfonyl)phenyl]-1,4-dichloro-2-butene

To a solution of 3.5 g (7.62 mmol) of crude 2-(4-fluorophenyl)-3-[(4-methylsulfonyl)phenyl]-1,4-dihydroxy-2-butene (prepared in Step 6) in 58 mL of N,N-dimethylformamide (DMF) at 5°C under an atmosphere of nitrogen was added dropwise 1.52 mL (20.84 mmol) of thionyl chloride. The reaction was stirred at 5°C for 22 hours, stirred at ambient temperature for an additional 8 hours, and concentrated in vacuo. The residue was partitioned between ethyl acetate and water; the ethyl acetate phase was dried (MgSO_4) and concentrated in vacuo to give crude 2-(4-fluorophenyl)-3-[(4-methylsulfonyl)phenyl]-1,4-dichloro-2-butene as a solid:

10 NMR (CDCl_3) δ 3.0 (s, 3H), 4.55 (d, $J = 3.4$ Hz, 4H), 6.86 (t, $J = 9$ Hz, 2H), 6.75 (d, $J = 8.3$ Hz, 2H), 7.45 (d, $J = 9$ Hz, 2H).

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20

Step 8, A: Preparation of 1-[2-(4-fluorophenyl)-4,4-dicarbomethoxycyclopenten-1-yl]-4-(methylsulfonyl)benzene

To a solution of 1.2 mL (10.5 mmol) of dimethyl malonate in 10 mL of DMF under an atmosphere of nitrogen was added 215 mg (26.9 mmol) of lithium hydride in portions. The resulting suspension was stirred at ambient temperature for 20 minutes prior to the addition of a solution of crude 2-(4-fluorophenyl)-3-[(4-methylsulfonyl)phenyl]-1,4-dichloro-2-butene (prepared in Step 7) in 10 mL of DMF. The reaction was stirred at ambient temperature for 15 hours, treated with another 150 mg (18.8 mmol) of lithium hydride, and stirred for

30

35

another 4 hours. The mixture was concentrated in vacuo and partitioned between ethyl acetate and water; the organic phase was dried ($MgSO_4$), and concentrated in vacuo. The residue was chromatographed on silica gel to give 1.1 g (34%) of 1-[2-(4-fluorophenyl)-4,4-dicarbomethoxycyclopenten-1-yl]-4-(methylsulfonyl)benzene as an oil: NMR ($CDCl_3$) δ 3.03 (s, 3H), 3.55 (s, 4H), 3.79 (s, 6H), 6.93 (t, $J = 9$ Hz, 2H), 7.11 (dd, $J = 6$ and 9 Hz, 2H), 7.32 (d, $J = 9$ Hz, 2H), 7.77 (d, $J = 9$ Hz, 2H).

10

Step 8. B: Preparation of 1-[2-(4-fluorophenyl)-4,4-dicarbomethoxycyclopenten-1-yl]-4-(methylsulfonyl)benzene

15 To a solution of 7.18 mL (63 mmol) of dimethyl malonate in 160 mL of DMF at 0°C under an atmosphere of nitrogen was added 3.0 g (75 mmol) of sodium hydride (60% suspension in oil). The reaction was stirred at ambient temperature for 15 minutes (or until the gas evolution has ceased), cooled to -20°C, and treated with 15 g (69 mmol) of 2-bromo-4'-fluoroacetophenone (Aldrich) in one portion. The mixture was stirred at ambient temperature for 1 hour and then cooled to 0°C; another 75 mmol of sodium hydride was added and the resulting mixture 20 stirred at ambient temperature for 15 minutes (or until the gas evolution has ceased). The reaction was recooled to -20°C and treated with 19.1 g (69 mmol) of 2-bromo-4'-(methylsulfonyl)acetophenone (prepared in Step 3). The reaction was stirred at room temperature for 2 hours and 25 concentrated in vacuo. The residue was partitioned between water and ethyl acetate; the ethyl acetate phase was dried ($MgSO_4$) and reconcentrated in vacuo. The residue was chromatographed on silica gel to give 13.8 g (51%) of dimethyl 2-[2-(4-fluorophenyl)-2-oxoethyl]-2-[2-30 [4-(methylsulfonyl)phenyl]-2-oxoethyl]propanedioate as an oil: NMR ($CDCl_3$) δ 3.06 (s, 3H), 3.76 (s, 6H), 4.03 (s, 2H), 4.08 (s, 2H), 7.13 (t, $J = 8.6$ Hz, 2H), 7.97-8.05 [m

with d at 8.03 (δ = 8.7 Hz), 4H], 8.14 (d, δ = 8.5 Hz, 2H).

To a vigorously stirred mixture of 50.4 g (771 mmol) of zinc dust in 640 mL of THF at -78°C under an atmosphere of nitrogen was added dropwise 60.4 mL (551 mmol) of titanium(IV) chloride. The reaction was warmed to ambient temperature with a water bath and then stirred at reflux for 1 hour. To the resulting dark mixture under reflux was added a solution of 15 g (32.3 mmol) of dimethyl 2-[2-(4-fluorophenyl)-2-oxoethyl]-2-[2-[4-(methylsulfonyl)phenyl]-2-oxoethyl]propanedioate (prepared above) in 20 mL of THF. The resulting mixture was stirred at ambient temperature for 16 hours, filtered through a pad of Celite®, rinsed with ethyl acetate, and concentrated in vacuo. The residue was partitioned between water and ethyl acetate; the organic phase was washed with brine, dried (MgSO₄), and concentrated in vacuo. The residue was chromatographed on silica gel to give 6.26 g (44%) of 1-[2-(4-fluorophenyl)-4,4-dicarbomethoxycyclopenten-1-yl]-4-(methylsulfonyl)benzene which was identical to the material prepared in Step 8, Method A.

25 Step 9: Preparation of 1-[2-(4-fluorophenyl)-4,4-di(hydroxymethyl)cyclopenten-1-yl]-4-(methylsulfonyl)benzene

Under nitrogen, a solution of 1.01 g (2.34 mmol) of 1-[2-(4-fluorophenyl)-4,4-dicarbomethoxycyclopenten-1-yl]-4-(methylsulfonyl)benzene (prepared in Step 8) in 1.5 mL of THF at -78°C was treated with 11.6 mL (11.6 mmol) of DIBAL (1.0 M in THF). The reaction was stirred at ambient temperature for 1.5 hours, quenched with acetone and aqueous NaOH, extracted with ethyl acetate, dried (MgSO₄), and concentrated in vacuo to give 840 mg of crude 1-[2-(4-fluorophenyl)-4,4-

di(hydroxymethyl)cyclopenten-1-yl]-4-(methylsulfonyl)benzene as a colorless oil: NMR (CDCl₃) δ 2.82 (d, J = 5 Hz, 4H), 3.04 (s, 3H), 3.86 (d, J = 5 Hz, 4H), 6.94 (t, J = 9 Hz, 2H), 7.11 (dd, J = 5 and 9 Hz, 5 H), 7.33 (d, J = 9 Hz, 2H), 7.77 (d, J = 9 Hz, 2H).

Step 10: Preparation of 1-[2-(4-fluorophenyl)-4,4-di(tosylmethyl)cyclopenten-1-yl]-4-(methylsulfonyl)benzene

10

Under nitrogen, a solution of 2.34 mmol of the crude 1-[2-(4-fluorophenyl)-4,4-di(hydroxymethyl)cyclopenten-1-yl]-4-(methylsulfonyl)benzene (prepared in Step 9) in 8 mL of pyridine at ambient temperature was treated with 1.2 g (6.3 mmol) of p-toluenesulfonyl chloride (tosyl chloride). The resulting solution was stirred at room temperature for 17 hours, concentrated in vacuo, and chromatographed on silica gel to give 1.06 g (66% overall yield from Step 9) of 1-[2-(4-fluorophenyl)-4,4-di(tosylmethyl)cyclopenten-1-yl]-4-(methylsulfonyl)benzene as a colorless solid: NMR (CDCl₃) δ 2.46 (s, 6H), 2.73 (s, 3H), 3.04 (s, 3H), 4.05 (s, 4H), 6.85-7.0 (m, 4H), 7.20 (d, J = 8 Hz, 2H), 7.34 (d, J = 8 Hz, 4H), 7.75 (d, J = 8 Hz, 6H).

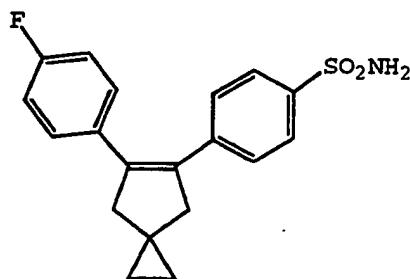
Step 11: Preparation of 5-(4-fluorophenyl)-6-[4-(methylsulfonylphenyl]spiro[2.4]hept-5-ene

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Under nitrogen, a solution of 1.02 g (1.49 mmol) of 1-[2-(4-fluorophenyl)-4,4-di(tosylmethyl)cyclopenten-1-yl]-4-(methylsulfonyl)benzene (prepared in Step 10) in 24 mL of DMF was treated with 3.23 g (21.55 mmol) of sodium iodide and 1.61 g (24.63 mmol) of zinc dust. The reaction was stirred at 150°C for 1.5 hour, concentrated in vacuo, and partitioned between water and ethyl acetate. The organic

phase was washed with sodium sulfite, water, brine, dried ($MgSO_4$), and concentrated in vacuo. The residue was chromatographed on silica gel to give 437 mg (86%) of 5-(4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene as a colorless solid: mp 140.5-142.0°C; NMR ($CDCl_3$) δ 0.69 (s, 4H), 2.92 (s, 4H), 3.04 (s, 3H), 6.93 (t, $J = 9$ Hz, 2H), 7.10 (dd, $J = 5$ and 9 Hz, 2H), 7.32 (d, $J = 8$ Hz, 2H), 7.76 (d, $J = 8$ Hz, 2H). HRMS Calc'd for $C_{20}H_{19}FO_2S$: 342.1090. Found: 342.1126. Anal. Calc'd for $C_{20}H_{19}FO_2S$: C, 70.15; H, 5.59; F, 5.55; S, 9.36. Found: C, 70.10; H, 5.69; F, 5.50; S, 9.60.

Example 2



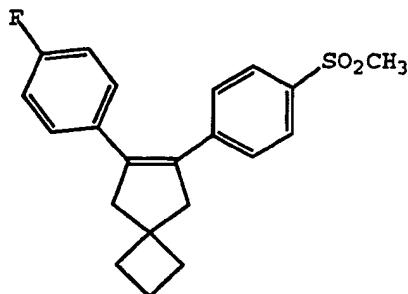
15

4-[6-(4-Fluorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

Under nitrogen, a solution of 90 mg (0.248 mmol) of 5-(4-fluoro phenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 1) in 1 mL of THF at -78°C was treated with 0.21 mL (0.27 mmol) of methyllithium (1.3 M in ether) over a period of 2 minutes. The reaction was stirred at ambient temperature for 25 minutes, cooled to -78°C, and treated with 0.3 mL (0.3 mmol) of tributylborane (1.0 M in THF). The resulting dark brown solution was stirred at ambient temperature for 20 minutes and then at reflux for 16 hours prior to the addition of 350 mg (4.27 mmol) of sodium acetate, 2 mL of

water, and 250 mg (2.21 mmol) of hydroxyamine-O-sulfonic acid. The resulting light orange mixture was stirred at ambient temperature for 3 hours and the aqueous phase extracted with ethyl acetate. The combined extracts were washed with water, brine, dried (MgSO_4), and concentrated in vacuo. The residue was chromatographed on silica gel to give 24 mg (27%) of 4-[6-(4-fluoro phenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a colorless solid: mp 131.0-133.0°C; NMR (CDCl_3) δ 0.68 (s, 4H), 2.90 (s, 3H), 4.81 (s, 2H), 6.92 (t, J = 9 Hz, 2H), 7.11 (dd, J = 6 and 9 Hz, 2H), 7.27 (d, J = 9 Hz, 2H), 7.74 (d, J = 9 Hz, 2H). HRMS Calc'd for $\text{C}_{19}\text{H}_{18}\text{FNO}_2\text{S}$: 344.1121. Found: 344.1122. Anal. Calc'd for [$\text{C}_{19}\text{H}_{18}\text{FNO}_2\text{S}$ + 0.1 $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$]: C, 66.16; H, 3.98; S, 9.11. Found: C, 65.86; H, 5.52; N, 3.92; S, 9.57.

Example 3



20 **6-(4-Fluorophenyl)-7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-ene**

Step 1: Preparation of 1-methylthio-4-[1-(trimethylsilyl)oxylethenyl]benzene

25 Under nitrogen, 11.0 g (66.2 mmol) of 4-(methylthio)acetophenone (prepared in Step 1 of Example 1) and 13.8 mL (99 mmol) of triethylamine in 50 mL of acetonitrile was treated with 12.6 mL (99.3 mmol) of chlorotrimethylsilane at ambient temperature and allowed 30 to stir for 20 minutes prior to the slow addition of a

suspension of 14.9 g (99.4 mmol) of sodium iodide in 60 mL of acetonitrile. The reaction was stirred for 3 hours, poured into ice/water, and extracted with hexane. The extracts were combined, dried (K_2CO_3), and 5 concentrated in vacuo to give 16 g of crude 1-methylthio-4-[1[(trimethylsilyl)oxy]ethenyl]benzene as an oil: NMR ($CDCl_3$) δ 0.26 (s, 9H), 2.48 (s, 3H), 4.39 (d, $J= 2$ Hz, 1H), 4.87 (d, $J= 2$ Hz, 1H), 7.20 (d, $J= 8$ Hz, 2H), 7.50 (d, $J= 8$ Hz, 2H).

10

Step 2: Preparation of 1-fluoro-4-[1-[
[(trimethylsilyl)oxy]ethenyl]benzene

Under nitrogen, 17.7 g (128 mmol) of 4-15 fluoroacetophenone (Aldrich) and 20.7 mL (192 mmol) of triethylamine at ambient temperature was treated with 24.4 mL (192.3 mmol) of chlorotrimethylsilane and allowed to stir of 20 minutes prior to the slow addition of a suspension of 30 g (200 mmol) of sodium iodide in 200 mL 20 of acetonitrile. The extracts were combined, dried (K_2CO_3), and concentrated in vacuo to give 27 g of crude 1-fluoro-4-[1[(trimethylsilyl)oxy]ethenyl]benzene as an oil: NMR ($CDCl_3$) δ 0.28 (s, 9H), 4.41 (d, $J= 2$ Hz, 1H), 4.84 (d, $J= 2$ Hz, 1H), 7.00 (d, $J= 8$ Hz, 2H), 7.53-7.60 25 (m, 2H).

Step 3: Preparation of 1-(4-fluorophenyl)-2-(1-
hydroxycyclobutan-1-yl)ethan-1-one

Under nitrogen, 11.0 g (100 mmol) of 30 titanium(IV) chloride in 140 mL of methylene chloride at 0°C was slowly treated with a solution of 8.2 mL (110 mmol) of cyclobutanone in 30 mL of methylene chloride prior to the dropwise addition of a solution of 21.1 g 35 (100 mmol) of 1-fluoro-4-[1[(trimethylsilyl)oxy]ethenyl]benzene (obtained from Step 2) in 15 mL of methylene chloride. The reaction

was stirred for 15 minutes and then poured into 200 mL of ice/water; the phases were separated. The aqueous phase was extracted twice with 30 mL of methylene chloride and combined with the original methylene chloride phase. The
5 combined extracts were washed 3 times with 120 mL of saturated sodium carbonate/water (1:1) and once with brine, dried (MgSO_4), and concentrated in vacuo to give 20.4 g (98%) of crude 1-(4-fluorophenyl)-2-(1-hydroxycyclobutan-1-yl)ethan-1-one as an oil: NMR (CDCl_3)
10 δ 1.53-1.70 (m, 1H), 1.80-1.94 (m, 1H), 1.99-2.10 (m, 2H), 2.17-2.31 (m, 2H), 3.31 (s, 2H), 7.10-7.19 (m, 2H), 7.95-8.03 (m, 2H).

15 Step 4: Preparation of 1-(4-fluorophenyl)-2-(cyclobutanylidene-1-yl)ethan-1-one

Under nitrogen, 20.3 g (98 mmol) of 1-(4-fluorophenyl)-2-(1-hydroxycyclobutan-1-yl)ethan-1-one (prepared in Step 3), 37 mL (260 mmol) of triethylamine,
20 and 50 mg of 4-dimethylaminopyridine (DMAP) in 80 mL of methylene chloride at 0°C was slowly treated with a solution of 16.6 mL (118 mmol) of trifluoroacetic anhydride (TFAA) in 40 mL of methylene chloride. The reaction was allowed to stir for 3 hours at 0°C and
25 warmed to ambient temperature to stir for an additional 3 hours prior to the addition of 200 mL of saturated sodium carbonate/water (1:1) and 300 mL of ether. The phases were separated and the aqueous phase was extracted twice with 100 mL of ether. The ether extracts were combined
30 with the original ether/methylene chloride phase, washed with brine, dried (MgSO_4), and concentrated in vacuo. Purification by silica gel chromatography (Waters Prep-500A) with ethyl acetate/hexane (2:98) gave 12.1 g (65%) of 1-(4-fluorophenyl)-2-(cyclobutanylidene-1-yl)ethan-1-one as an oil: NMR (CDCl_3) δ 2.11-2.24 (m, 2H), 2.95 (t, J= 8 Hz, 2H), 3.19-3.29 (m, 2H), 2.68-2.74 (m, 1H), 7.05-7.16 (m, 2H), 7.84-7.97 (m, 2H).

Step 5: Preparation of 1-(4-fluorophenyl)-2-[1-[2-[4-(methylthio)phenyl]-2-oxoethyl]cyclobutan-1-yl]ethan-1-one

5

Under nitrogen, 7.2 mL (70.2 mmol) of titanium(IV) chloride in 100 mL of methylene chloride at -78°C was slowly treated with a solution of 12.1 g (63.8 mmol) of 1-(4-fluorophenyl)-2-(cyclobutanylidene-1-yl)ethan-1-one (prepared in Step 4) in 30 mL of methylene chloride. The mixture was stirred for 10 minutes, then 16.7 g (70.2 mmol) of the silyl enol ether (from Step 1) in 40 mL of methylene chloride was added dropwise. The reaction was stirred at -78°C for 1 hour, poured into a solution of 22 g of sodium carbonate in 160 mL of water, and filtered through Celite®. The phases were separated and the aqueous phase extracted twice with 40 mL of methylene chloride. The extracts were combined with the original methylene chloride phase and washed with brine, dried (MgSO_4), and concentrated in vacuo. Purification by silica gel chromatography (Waters Prep-500A) with ethyl acetate/hexane (10:90) gave 1-(4-fluorophenyl)-2-[1-[2-[4-(methylthio)phenyl]-2-oxoethyl]cyclobutan-1-yl]ethan-1-one as an oil: NMR (CDCl_3) δ 1.91-2.04 (m, 2H), 2.11 (t, $J = 8$ Hz, 4H), 2.49 (s, 3H), 3.48 (s, 2H), 3.49 (s, 2H), 7.08 (t, $J = 8$ Hz, 2H), 7.23 (t, $J = 8$ Hz, 2H), 7.84 (d, $J = 9$ Hz, 2H), 7.91-7.99 (m, 2H).

30 Step 6: Preparation of 1-(4-fluorophenyl)-2-[1-[2-[4-(methylsulfonyl)phenyl]-2-oxoethyl]cyclobutan-1-yl]ethan-1-one

A solution of 18.3 g (51.4 mmol) of 1-(4-fluorophenyl)-2-[1-[2-[4-(methylthio)phenyl]-2-oxoethyl]cyclobutan-1-yl]ethan-1-one (prepared in Step 5) in 200 mL of chloroform at 10°C was slowly treated with 35.6 g (ca. 103 mmol) of solid *m*-chloroperbenzoic acid

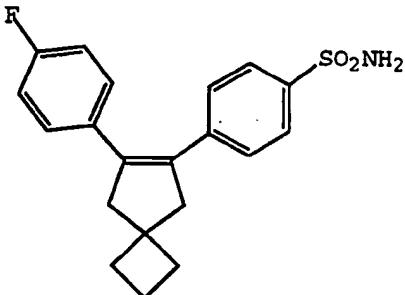
(50-60%). The reaction was allowed to stir for 30 minutes and treated with aqueous sodium bisulfite. The chloroform was removed in vacuo and the residue partitioned between ethyl acetate and water. The ethyl 5 acetate extracts were washed 3 times with saturated sodium bicarbonate and once with brine, dried ($MgSO_4$), and concentrated in vacuo to give 19.27 g (97%) of 1-(4-fluorophenyl)-2-[1-[2-[4-(methylsulfonyl)phenyl]-2-oxoethyl]cyclobutan-1-yl]ethan-1-one as an oil: NMR 10 ($CDCl_3$) δ 1.95-2.06 (m, 2H), 2.11 (t, $J= 7$ Hz, 4H), 3.05 (s, 3H), 3.52 (s, 2H), 3.59 (s, 2H), 7.09 (t, $J= 9$ Hz, 2H), 7.92-8.04 (m, 4H), 8.19 (d, $J= 9$ Hz, 2H).

15 Step 7: Preparation of 6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-ene

Under nitrogen, 16.3 mL (149 mmol) of titanium(IV) chloride was slowly added to a suspension of 19.5 g (298 mmol) of zinc dust in 500 mL of anhydrous THF 20 at -78°C. The resulting mixture was allowed to warm to ambient temperature and then to stir at reflux for 45 minutes. The reaction was cooled to ambient temperature prior to the addition of 19.27 g (49.6 mmol) of neat 1-(4-fluorophenyl)-2-[1-[2-[4-(methylsulfonyl)phenyl]-2-oxoethyl]cyclobutan-1-yl]ethan-1-one (prepared in Step 6) 25 by syringe. The reaction was allowed to stir at ambient temperature overnight, filtered through Celite®, and concentrated in vacuo. The residue was partitioned between ethyl acetate and water; the ethyl acetate phase 30 was washed with brine, dried ($MgSO_4$), and concentrated in vacuo. Purification by silica gel chromatography (Waters Prep-500A) with ethyl acetate/hexane (20:80) gave 13.5 g (76%) of 6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-ene as a colorless solid: mp 123-124°C; 35 NMR ($CDCl_3$) δ 1.85-1.98 (m, 2H), 2.08 (t, $J= 7$ Hz, 4H), 2.98 (s, 4H), 3.04 (s, 3H), 6.92 (t, $J= 9$ Hz, 7.05-7.13 (m, 2H), 7.30 (t, $J= 8$ Hz, 2H), 7.75 (t, $J= 8$ Hz, 2H).

MS (FAB) m/e 357 (M+H). Anal. Calc'd for C₂₁H₂₁FO₂S: C, 70.76; H, 5.94; F, 5.53; S, 8.99. Found: C, 70.76; H, 6.10; F, 5.20; S, 8.96.

Example 4

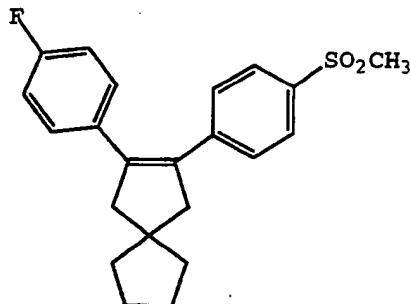


5

4-[7-(4-Fluorophenyl)spiro[3.4]oct-6-en-6-yl]benzenesulfonamide

10 Following a procedure similar to the one described in Example 2, 1.76 g (4.94 mmol) of 6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-ene (the title compound of Example 3) was converted to 1.61 g of crude sulfonamide. Purification by silica gel chromatography
15 with ethyl acetate/hexane (20:80) and subsequent recrystallization from chloroform/hexane gave 970 mg (55%) of 4-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]benzenesulfonamide as a colorless solid: mp 118-119°C; NMR (CDCl₃) δ 1.92 (m, J= 8 Hz, 2H), 2.08 (t, J= 7 Hz,
20 4H), 2.97 (s, 3H), 4.74 (s, 2H), 6.92 (t, J= 9 Hz, 2H), 7.06-7.13 (m, 2H), 7.23-7.30 (m, 2H), 7.74 (t, J= 8 Hz, 2H). MS (EI) m/e (rel intensity) 357 (100), 329 (48), 248 (66), 233 (44), 109 (32). Anal. Calc'd for C₂₀H₂₀FNO₂S: C, 67.21; H, 5.64; N, 3.93; F, 5.32; S, 8.97.
25 Found: C, 66.83; H, 5.89; N, 3.83; F, 4.96; S, 9.03.

Example 5

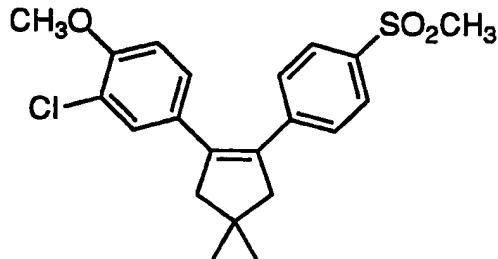


2-(4-Fluorophenyl)-3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-ene

5

Following a procedure similar to the one described in Example 3 with the substitution of cyclopentanone for cyclobutanone, 23 mg of 2-(4-fluorophenyl)-3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-ene was obtained as a colorless solid: mp 142-143°C; NMR (CDCl_3) δ 1.72 (s, 8H), 2.83 (s, 4H), 3.04 (s, 3H), 6.93 (t, $J = 9$ Hz, 2H), 7.10 (dd, $J = 5$ and 9 Hz, 2H), 7.31 (d, $J = 9$ Hz, 2H), 7.76 (d, $J = 9$ Hz, 2H). HRMS Calc'd for $\text{C}_{22}\text{H}_{23}\text{FO}_2\text{S}$: 370.1403. Found: 370.1411. Anal. Calc'd for $\text{C}_{22}\text{H}_{23}\text{FO}_2\text{S}$: C, 71.32; H, 6.26; F, 5.13; S, 8.65. Found: C, 71.66; H, 6.36; F, 4.91; S, 9.13.

Example 6



20

5-(3-Chloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

25 Step 1: Preparation of 4-(methylthio)acetophenone

To a stirred solution of 98.93 g (0.63 mol) of 4-(methylthio)benzonitrile in 1.2 L of THF under nitrogen at -78 °C was added 568 mL (0.795 mol) of methyllithium (1.4 M in ethyl ether). The resulting dark red solution was warmed to room temperature, and stirred for another 2.5 hours. The reaction was slowly quenched with 400 mL of 3 N HCl, and the resulting mixture was stirred overnight at room temperature. The mixture was concentrated in vacuo to about 500 mL, diluted with ethyl acetate and washed with saturated NaHCO₃, brine, dried (MgSO₄) and concentrated in vacuo to give 108.5 g (98.5%) of 4-(methylthio)acetophenone as a yellow solid: NMR (CDCl₃) δ 2.52 (s, 3H), 2.56 (s, 3H), 7.28 (d, J = 8.6 Hz, 2H), 7.86 (d, J = 8.6 Hz, 2H).

Step 2: Preparation of 4-(methylsulfonyl)acetophenone

To a solution of 108.5 g (0.653 mol) of 4-(methylthio)acetophenone (prepared in Step 1) in 3 L of methylene chloride at 0 °C was added in portions 414 g (68%, 1.63 mol) of MCPBA over a period of one hour. The mixture was stirred at room temperature overnight. To the cooled white suspension was added slowly a solution of 124 g (0.653 mol) of meta bisulfite in 300 mL of water and the mixture was stirred at room temperature for one hour, then filtered. The filtrate was concentrated in vacuo to about 1 L, and repeatedly washed carefully with saturated NaHCO₃ to remove 3-chlorobenzoic acid. The extract was dried (MgSO₄) and concentrated in vacuo to give 117.33 g (91%) of 4-(methylsulfonyl)acetophenone as a bright yellow solid: NMR (CDCl₃) δ 2.67 (s, 3H), 3.08 (s, 3H), 8.05 (d, J = 8.5 Hz, 2H), 8.14 (d, J = 8.5 Hz, 2H).

35

Step 3: Preparation of 2-bromo-4'-(methylsulfonyl)acetophenone

To a solution of 117 g (0.593 mol) of 4-(methylsulfonyl)acetophenone (prepared in Step 2) in 1 L of glacial acetic acid was added 1 mL of concentrated HCl. To the resulting solution was added dropwise a solution of 94.75 g (0.593 mol) of bromine in 100 mL of glacial acetic acid over a period of about 45 minutes, and the resulting light orange solution was poured onto about 2 L of ice. The resulting yellow precipitate was collected by filtration, washed with 2 L of water and dried (MgSO_4) to give 161 g (87% pure by ^1H NMR analysis, 86% calculated yield) of 2-bromo-4'-(methylsulfonyl)acetophenone as a yellow solid: NMR (CDCl_3) δ 3.10 (s, 3H), 4.45 (s, 2H), 8.08 (d, $J = 8.7$ Hz, 2H), 8.17 (d, $J = 8.6$ Hz, 2H).

Step 4: Preparation of dimethyl keto malonate

Under nitrogen, 161.8 g (0.508 mol) of 2-bromo-4'-(methylsulfonyl)acetophenone (prepared in Step 3) was added to a suspension of 133.44 g (1.01 mol) of dimethyl malonate, 350.5 g (2.54 mol) of potassium carbonate (Aldrich), and 38.1 g (0.254 mol) of potassium iodide in 450 mL of THF, and the resulting suspension was stirred at room temperature for 6 hours (exothermic, temperature reached 40 °C in 30 minutes). The mixture was filtered, concentrated in vacuo, and the residue was recrystallized from ethyl acetate. The mother liquor was concentrated in vacuo and purified by silica gel chromatography (Prep-500, Waters), eluted with 15% of ethyl acetate in methylene chloride, to give a total of 100 g (63.3 %) of dimethyl keto malonate as a white solid: ^1H NMR (CDCl_3) δ 3.07 (s, 3H), 3.64 (d, $J = 7.05$ Hz, 2H), 3.78 (s, 6H), 4.09 (t, $J = 7.04$ Hz, 1H), 8.05 (d, $J = 8.7$ Hz, 2H), 8.15 (d, $J = 8.7$ Hz, 2H).

Step 5: Preparation of 3-chloro-4-methoxybenzamide

To a solution of 132.5 g (0.71 mol) of 3-chloro-4-methoxybenzoic acid in 514 mL (7.05 mol) of thionyl chloride was added in portions 2.5 mL of DMF, and
5 the resulting solution was stirred under reflux for 4 hours. The mixture was concentrated in vacuo and dissolved in 600 mL of methylene chloride. To the resulting solution was added 83.1 g (0.85 mol) of N,O-dimethylhydroxyamine (HCl salt) and cooled to 0 °C. To
10 the suspension was added slowly 198 mL (1.4 mL) of triethylamine, and the mixture was stirred at room temperature overnight. The resulting solution was washed twice with 1 N KHSO₄, NaHCO₃, brine, dried (MgSO₄) and concentrated in vacuo to give 163.2 g (quantitative) of
15 3-chloro-4-methoxybenzamide as a light brown oil: ¹H NMR (CDCl₃) δ 3.35 (s, 3H), 3.56 (s, 3H), 3.94 (s, 3H), 6.93 (d, J = 8.7 Hz, 1H), 7.68 (dd, J = 2.2, 8.7 Hz, 1H), 7.82 (d, J = 2.1 Hz, 1H).

20 Step 6: Preparation of 3-chloro-4-methoxyacetophenone

To a stirred solution of 64.7 g (0.28 mol) of 3-chloro-4-methoxybenzamide (prepared in Step 5) in 1 L of THF under nitrogen at -78 °C was added 110 mL (3 M in
25 ethyl ether, 0.3 mol) of methylmagnesium bromide. The resulting solution was warmed to room temperature, and stirred for another 3 hours. The reaction was slowly quenched with 3 N HCl, diluted with ethyl acetate and washed with saturated NaHCO₃, brine, dried (MgSO₄) and
30 concentrated in vacuo to give 51.7 g (99%) of 3-chloro-4-methoxyacetophenone as a off-white solid: ¹H NMR (CDCl₃) δ 2.55 (s, 3H), 3.97 (s, 3H), 6.96 (d, J = 8.5 Hz, 1H), 7.86 (dd, J = 2.2, 8.7 Hz, 1H), 7.98 (d, J = 2.2 Hz, 1H).

35 Step 7: Preparation of 2-bromo-(3'-chloro-4'-methoxy)acetophenone

To a solution of 51.7 g (0.28 mol) of 3-chloro-4-methoxyacetophenone (prepared in Step 6) in 103 mL of glacial acetic acid was added 1 mL of concentrated HCl.

5 To the resulting solution was added dropwise a solution of 14.5 mL (0.28 mol) of bromine in 20 mL of glacial acetic acid over a period of about 1.5 hours, and the resulting dark solution was stirred at room temperature for 2 hours. The precipitate was collected by filtration and washed with water. More solid was collected from the

10 filtrate. The combined solid was dried to give 65 g (88%) of 2-bromo-(3'-chloro-4'-methoxy)acetophenone as a yellow solid: NMR (CDCl_3) δ 3.99 (s, 3H), 4.37 (s, 2H), 6.99 (d, $J = 8.7$ Hz, 1H), 7.91 (dd, $J = 2.4, 8.7$ Hz, 1H), 8.03 (d, $J = 2.2$ Hz, 1H).

15

Step 8: Preparation of dimethyl diketo malonate

Under nitrogen, 30 g (0.114 mol) of 2-bromo-(3'-chloro-4'-methoxy)acetophenone (prepared in Step 7)

20 was added in three portions over 24 hours to a stirred suspension of 24 g (0.077 mol) of dimethyl keto malonate (prepared in Step 4), 42 g (0.3 mol) of potassium carbonate (Aldrich), and 6 g (0.04 mol) of potassium iodide in 85 mL of THF. The mixture was filtered through

25 a silica gel plug, eluted with ethyl acetate/hexane (1:1) and concentrated in vacuo. The residue was purified by silica gel chromatography (Prep-500, Waters), eluted with 33% of ethyl acetate in hexane, to give 27.8 g (73%) of dimethyl diketo malonate as a white solid.

30

Step 9: Preparation of diaryl cyclopentenyl diester

To a vigorously stirred suspension of 38.4 g (0.249 mol) of titanium(III) chloride in 400 mL of DME

35 under nitrogen was added 14 g (0.214 mol) of zinc dust (Aldrich), and the resulting mixture was stirred under reflux for one hour. To the dark solution at reflux was

added 27.8 g (0.054 mol) of dimethyl diketo malonate (prepared in Step 8), and the resulting mixture was stirred under reflux for one hour. The mixture was filtered, concentrated in vacuo, diluted with ethyl acetate, washed with water, saturated NaHCO₃, brine, dried (MgSO₄) and concentrated in vacuo. The residue was purified by silica gel chromatography to give 13 g (50%) of diaryl cyclopentenyl diester as a pale yellow solid: ¹H NMR (CDCl₃) δ 3.04 (s, 3H), 3.5-3.6 (m, 4H), 3.80 (s, 6H), 5 3.88 (s, 3H), 6.77 (d, J = 8.7 Hz, 1H), 6.95 (dd, J = 2.2, 8.7 Hz, 1H), 7.19 (d, J = 2.0 Hz, 1H), 7.35 (dd, J = 1.8, 6.9 Hz, 2H), 7.79 (dd, J = 1.8, 6.8 Hz, 2H).

10 Step 10: Preparation of diaryl cyclopentenyl diol

15 To a solution of 13 g (27.2 mmol) of cyclopentenyl diester (prepared in Step 9) in 200 mL of THF under nitrogen at -78 °C was added 100 mL (150 mmol) of DIBAL (1.5 M in toluene) over a period of 30 minutes.

20 The resulting solution was stirred at -78 °C for 15 minutes, then at room temperature overnight. The reaction mixture was carefully quenched sequentially with 15 mL of acetone, 30 mL of water (caution: exothermic) and 90 mL of 10% NaOH. The aqueous layer was extracted with ethyl acetate, and the combined extracts were washed with saturated NaHCO₃, 1 N HCl, water, and brine. The extract was dried (MgSO₄) and concentrated in vacuo to give 11.8 g of colorless oil which was used directly in Step 11: ¹H NMR (CDCl₃) δ 2.35 (s, 2H), 2.78 (d, J = 10.5 Hz, 4H), 25 3.04 (s, 3H), 3.83 (s, 4H), 3.87 (s, 3H), 6.76 (d, J = 8.7 Hz, 1H), 6.95 (dd, J = 2.2, 8.7 Hz, 1H), 7.18 (d, J = 2.1 Hz, 1H), 7.34 (d, J = 1.8, 6.8 Hz, 2H), 7.77 (dd, J = 1.8, 6.6 Hz, 2H).

30 35 Step 11: Preparation of diaryl cyclopentenyl ditosylate

To a solution of 11.8 g (26.8 mmol) of crude diaryl cyclopentenyl diol (prepared in Step 10) in 92 mL of pyridine under nitrogen at 0 °C was added 23 g (120 mmol) of *p*-toluenesulfonyl chloride in portions
5 (exothermic) and the resulting dark solution was stirred at room temperature overnight. The mixture was concentrated in vacuo to remove pyridine, and the residue was dissolved in ethyl acetate. The solution was washed with water, 1 N HCl, NaHCO₃, brine, dried (MgSO₄) and
10 concentrated in vacuo. The residue was chromatographed to give 11.6 g (59% from diester) of diaryl cyclopentenyl ditosylate as a tan solid: ¹H NMR (CDCl₃) δ 2.46 (s, 6H), 2.70 (d, J = 15.1 Hz, 4H), 3.04 (s, 3H), 3.88 (s, 3H), 4.03 (s, 4H), 6.74 (d, J = 8.7 Hz, 1H), 6.85 (dd, J = 2.2, 15 8.7 Hz, 1H), 7.00 (d, J = 2.0 Hz, 1H), 7.19 - 7.25 (m, 2H), 7.35 (d, J = 8.1 Hz, 4H), 7.7-7.82 (m, 6H).

Step 12: Preparation of 5-(3-chloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Under nitrogen, a solution of 11.6 g (15.9 mmol) of diaryl cyclopentenyl ditosylate (prepared in Step 11) in 260 mL of DMF was treated with 34.7 g (231 mmol) of sodium iodide and 17.2 g (263 mmol) of zinc dust. The
20 resulting mixture was stirred at 150 °C for 3 hours, and concentrated in vacuo. The residue was dissolved in ethyl acetate, and the solid was filtered off. The filtrate was washed with sodium sulfite, water, brine, dried (MgSO₄), and concentrated in vacuo. The residue was
25 chromatographed on silica gel to give 5.32 g (86%) of pale yellow solid. The solid was recrystallized to give 2.32 g of 5-(3-chloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene as a white solid: mp 140.0-140.5 °C; ¹H NMR (CDCl₃) δ 0.68 (s, 4H), 2.84-2.95 (m, 4H), 3.04 (s, 3H), 3.88 (s, 3H), 6.76 (d, J = 8.5 Hz, 1H), 6.95 (dd, J = 2.0, 8.5 Hz, 1H), 7.18 (d, J = 2.0 Hz, 1H), 7.35 (dd, J = 1.6, 6.7 Hz, 2H), 7.77 (dd, J

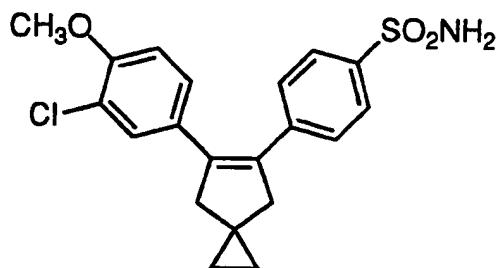
104

= 1.8, 6.6 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₂₁ClO₃S: 388.0900. Found: 388.0909. Anal. Calc'd for C₂₁H₂₁ClO₃S: C, 64.93; H, 5.45; S, 8.24. Found: C, 64.77; H, 5.65; S, 8.53.

5 The mother liquor from the recrystallization described above was concentrated in vacuo to give 3.0 g of pale yellow solid which was used directly in the preparation of the title compound of Example 7.

10

Example 7



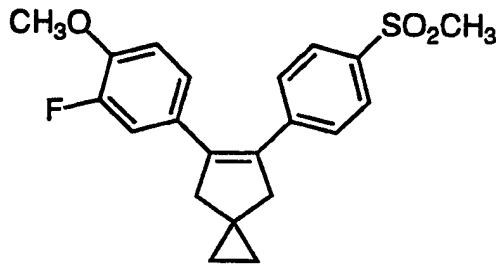
15 **4-[6-(3-Chloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide**

Under nitrogen, a solution of 3.6 g (9.26 mmol) of 5-(3-chloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title 20 compound of Example 6) in 10 mL of THF at 0 °C was treated with 6.3 mL (10.08 mmol) of propylmagnesium chloride (1.6 M in ether). The reaction mixture was stirred at ambient temperature for 25 minutes, cooled to 0 °C, and treated with 16.5 mL (1.0 M in THF, 16.5 mmol) of tributylborane 25 (or triethylborane). The resulting solution was stirred at ambient temperature for 15 minutes and then at reflux for 18 hours prior to the addition of 7 g (85 mmol) of sodium acetate, 18 mL of water, and 4 g (35 mmol) of hydroxyamine-O-sulfonic acid at 0 °C. The resulting light 30 orange mixture was stirred at ambient temperature for 3.5 hours and the aqueous phase was extracted with ethyl acetate. The combined extracts were washed with water, brine, dried (MgSO₄), and concentrated in vacuo. The

residue was chromatographed on silica gel to give 2.5 g (59%) of 4-[6-(3-chloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 191.0-192.0 °C; ^1H NMR (CDCl_3) δ 0.63 (s, 4H), 2.84 (s, 4H),
 5 3.83 (s, 3H), 5.74 (br s, 2H), 6.72 (d, J = 8.5 Hz, 1H),
 6.92 (dd, J = 2.0, 8.5 Hz, 1H), 7.15 (d, J = 2.2 Hz, 1H),
 7.24 (dd, J = 2.0, 6.9 Hz, 2H), 7.72 (dd, J = 1.8, 6.7 Hz,
 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{20}\text{ClNO}_3\text{S}$: 389.0852.
 Found: 389.0869. Anal. Calc'd for $[\text{C}_{20}\text{H}_{20}\text{ClNO}_3\text{S} + 0.05$
 10 CH_2Cl_2]: C, 61.61; H, 5.17; N, 3.59; S, 8.22. Found: C,
 61.06; H, 5.25; N, 3.51; S, 8.24.

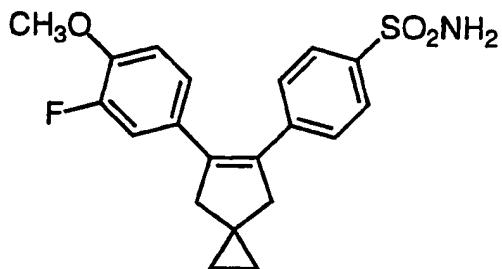
Example 8

15



5-(3-Fluoro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

20 Following a procedure similar to the one described in Example 6, with the substitution of 3'-fluoro-4'-methoxyacetophenone (Aldrich) for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3-fluoro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 110.5-111.5 °C; ^1H NMR (CDCl_3) δ 0.68 (s, 4H), 2.85-2.95 (m, 4H), 3.05 (s, 3H), 3.87 (s, 3H), 6.77-6.94 (m, 3H), 7.35 (d, J = 8.4 Hz, 2H), 7.78 (d, J = 8.7 Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{21}\text{H}_{21}\text{FO}_3\text{S}$: 372.1192. Found: 372.1187. Anal. Calc'd for
 25 $\text{C}_{21}\text{H}_{21}\text{FO}_3\text{S}$: C, 67.72; H, 5.68; F, 5.10; S, 8.61. Found:
 30 C, 67.31; H, 5.68; F, 5.16; S, 8.62.

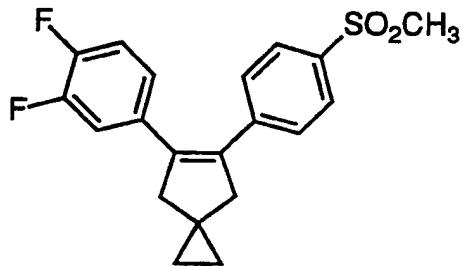
Example 9

5 4-[6-(3-Fluoro-4-methoxyphenyl)spiro[2.4]hept-5-
en-5-yl]benzenesulfonamide

Following a procedure similar to the one described in Example 7, 1.40 g (3.76 mmol) of 5-(3-fluoro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 8) was converted to crude sulfonamide. Purification by silica gel chromatography gave 0.88 g (63%) of 4-[6-(3-fluoro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 153.0-154.0 °C; ¹H NMR (CDCl₃) δ 0.68 (s, 4H), 2.89 (s, 4H), 3.87 (s, 3H), 4.79 (s, 2H), 6.75-6.93 (m, 3H), 7.31 (d, J = 8.7 Hz, 2H), 7.77 (d, J = 8.4 Hz, 2H). HRMS (EI) Calc'd for C₂₀H₂₀FNO₃S: 373.1148. Found: 373.1172. Anal. Calc'd for C₂₀H₂₀FNO₃S: C, 64.33; H, 5.40; N, 3.75; F, 5.09. Found: C, 64.28; H, 5.49; N, 3.77; F, 5.23.

Example 10

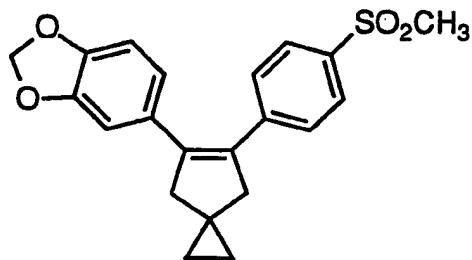
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5-(3,4-Difluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one
 5 described in Example 6 with the substitution of 3',4'-difluoroacetophenone (Aldrich) for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3,4-difluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was obtained
 10 as a white solid: mp 113-114 °C. MS (FAB): m/z 367 (M+Li), HRMS Calc'd for C₂₀H₁₈F₂O₂S: 360.0996, found 360.1014. ¹H NMR (CDCl₃) δ 0.69 (s, 4H), 2.90 (s, 2H), 2.92 (s, 2H), 3.06 (s, 3H), 6.80-6.87 (m, 1H), 6.91-7.07 (m, 2H), 7.33 (d, J = 8 Hz, 2H), 7.79 (d, J = 8 Hz, 2H).
 15 Anal. Calc'd for C₂₀H₁₈F₂O₂S: C, 66.65; H, 5.03. Found: C, 66.50; H, 5.02.

Example 11



20

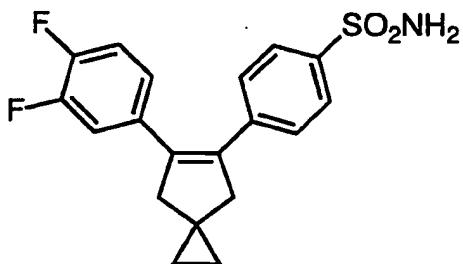
5-[6-[4-(Methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]-1,3-benzodioxole

Following a procedure similar to that described
 25 in Example 6, with the substitution of 3',4'-(methylenedioxy)acetophenone [prepared by the addition of methylolithium to piperonylonitrile (Aldrich), see Example 6, Step 1] for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]-1,3-benzodioxole was prepared as a white solid:
 30 mp 110.5-111.5 °C; ¹H NMR (CDCl₃) δ 0.67 (s, 4H), 2.89 (br d, J = 2.4 Hz, 4H), 3.05 (s, 3H), 5.94 (s, 2H), 6.55-6.67

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(m, 2H), 6.70 (d, J = 8.1 Hz, 1H), 7.36 (d, J = 8.5 Hz, 2H), 7.76 (d, J = 8.5 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₂₀O₄S: 368.1082. Found: 368.1077. Anal. Calc'd for C₂₁H₂₀O₄S: C, 68.46; H, 5.47; S, 8.70. Found: C, 68.13; H, 5.65; S, 8.81.

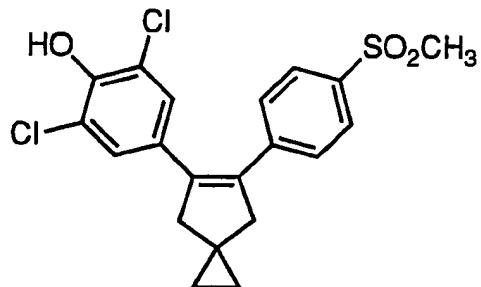
Example 12



10

4-[6-(3,4-Difluorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

Following a procedure similar to the one
15 described in Example 7, 880 mg (2.44 mmol) of 5-(3,4-difluorophenyl)-6-[4-(methyldifluorophenyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 10) was converted to crude sulfonamide. Purification by silica gel chromatography
20 (MPLC) with ethyl acetate/hexane (1:5) as the eluent followed by recrystallization from methylene chloride/hexane gave 370 mg (42%) of 4-[6-(3,4-difluorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 136-137 °C. MS (FAB): m/z 362 (M+H); HRMS Calc'd for C₁₉H₁₇F₂NO₂S: 361.0948, found: 361.0952. ¹H NMR (CDCl₃) δ 0.68 (s, 4H), 2.89 (s, 2H), 2.90 (s, 2H), 4.79 (s, 2H), 6.81-6.87 (m, 1H), 6.91-7.06 (m, 2H), 7.28 (d, J = 8 Hz, 2H), 7.78 (d, J = 8 Hz, 2H).
25 Anal. Calc'd for [C₁₉H₁₇F₂NO₂S + 0.29 CH₂Cl₂]: C, 60.00; H, 4.59; N, 3.63; F, 9.84; S, 8.30. Found: C, 59.96; H, 4.57; N, 3.50; F, 10.05; S, 8.35.

Example 13

5 **2,6-Dichloro-4-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]phenol**

10 Step 1: Preparation of 3,5-dichloro-4-methoxybenzoic acid

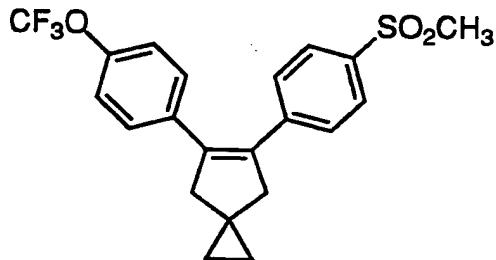
Under nitrogen, a mixture of 41.4 g (0.200 mol) of 3-chloro-4-hydroxybenzoic acid, 75 mL (1.2 mol) of iodomethane, and 81.5 g (0.25 mol) of potassium carbonate in 250 mL of DMF was stirred at 55 °C for 18 hours. The reaction mixture was filtered and concentrated in vacuo. The residue was dissolved in ethyl acetate, washed with water, brine, dried ($MgSO_4$) and concentrated in vacuo. The residue was dissolved in 84 mL of methanol and 84 mL of 2.5 N NaOH, and the resulting mixture was stirred at reflux for 4 hours. The reaction was concentrated in vacuo. The residue was dissolved in 600 mL of water, and pH was adjusted to 2 with concentrated HCl. The solution was extracted with ethyl acetate, and the combined extracts were washed with brine, dried ($MgSO_4$) and concentrated in vacuo to give 38.12 g (89%) of 3,5-dichloro-4-methoxybenzoic acid as a white solid: 1H NMR ($CDCl_3$) δ 3.95 (s, 3H), 7.98 (s, 2H)

30 Step 2: Preparation of 2,6-dichloro-4-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]phenol

Following a procedure similar to the one described in Example 6, with the substitution of 3,5-dichloro-4-methoxybenzoic acid (prepared in Step 1) for 3-chloro-4-methoxybenzoic acid (Example 6, Step 5), 2,6-dichloro-4-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]phenol was isolated instead of the expected 5-(3,5-dichloro-4-methoxy-phenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene. The title product compound was recrystallized as a white solid: mp 163.5-164.5 °C; ^1H NMR (CDCl_3) δ 0.68 (s, 4H), 2.88 (br d, J = 12.5 Hz, 4H), 3.05 (s, 3H), 5.83 (s, 2H), 7.02 (s, 2H), 7.35 (d, J = 8.4 Hz, 2H), 7.81 (d, J = 8.4 Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{18}\text{Cl}_2\text{O}_3\text{S}$: 408.0354. Found: 408.0349. Anal. Calc'd for $\text{C}_{20}\text{H}_{18}\text{Cl}_2\text{O}_3\text{S}$: C, 58.69; H, 4.43; Cl, 17.32; S, 7.83. Found: C, 58.47; H, 4.55; Cl, 17.24; S, 7.65

Example 14

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25 6-[4-(Methylsulfonyl)phenyl]-5-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 4'-trifluoromethoxyacetophenone (Aldrich) for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 6-[4-(methylsulfonyl)phenyl]-5-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-ene was prepared as a white solid: mp 126.0-127.0 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.93 (s, 4H), 3.05 (s, 3H), 7.08 (d, J = 8.7 Hz,

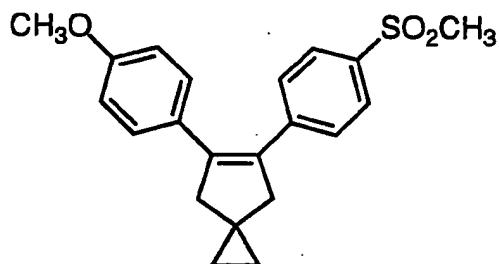
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111

2H), 7.16 (d, δ = 8.7 Hz, 2H), 7.33 (d, δ = 8.4 Hz, 2H), 7.78 (d, δ = 8.1 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₁₉F₃O₃S: 408.1007. Found: 408.1017. Anal. Calc'd for [C₂₁H₁₉F₃O₃S + 0.12 H₂O]: C, 61.43; H, 4.72; F, 13.88; S, 7.81. Found: C, 61.54; H, 4.76; F, 13.32; S, 7.98

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Example 15



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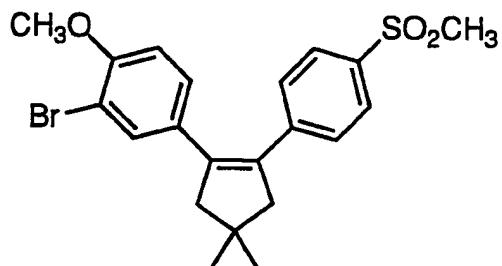
5-(4-Methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 2-bromo-4'-methoxyacetophenone (Aldrich) for 2-bromo-3'-chloro-4'-methoxyacetophenone (Example 6, Step 8), 5-(4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 170.2-173.0 °C; ¹H NMR (CDCl₃) δ 0.67 (s, 4H), 2.91 (s, 4H), 3.04 (s, 3H), 3.79 (s, 3H), 6.77 (d, δ = 8.9 Hz, 2H), 7.07 (d, δ = 8.9 Hz, 2H), 7.35 (d, δ = 8.5 Hz, 2H), 7.75 (d, δ = 8.7 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₂₂O₃S: 354.1290. Found: 354.1317. Anal. Calc'd for C₂₁H₂₂O₃S: C, 71.16; H, 6.26; S, 9.04. Found: C, 70.92; H, 6.20; S, 8.96.

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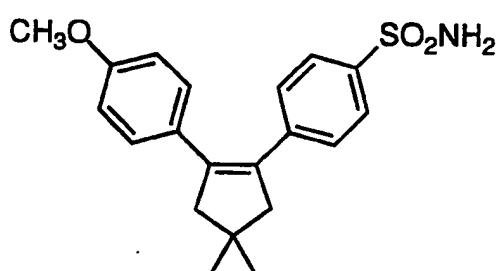
Example 16



5 5-(3-Bromo-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 3'-bromo-4'-methoxyacetophenone [prepared by the addition of methylmagnesium bromide to 3-bromo-4-methoxybenzaldehyde (Aldrich), followed by MnO₂ oxidation of the resulting alcohol] for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3-bromo-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 89.5-91.8 °C; ¹H NMR (CDCl₃) δ 0.68 (s, 4H), 2.85-2.93 (m, 4H), 3.04 (s, 3H), 3.87 (s, 3H), 6.73 (d, J = 8.7 Hz, 1H), 6.97 (dd, J = 2.5, 7.5 Hz, 1H), 7.3-7.4 (m, 3H), 7.78 (d, J = 8.5 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₂₁BrO₃S: 432.0395. Found: 432.0375. Anal. Calc'd for [C₂₁H₂₁BrO₃S + 0.64 CH₂Cl₂]: C, 53.31; H, 4.61; Br, 16.39. Found: C, 53.12; H, 4.54; Br, 16.74.

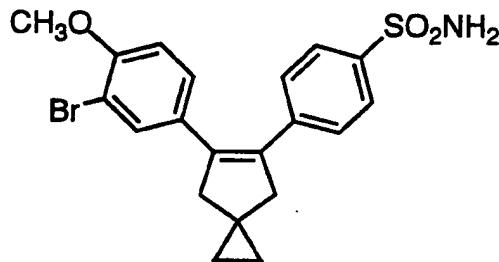
Example 17



25 4-[6-(4-Methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

Following a procedure similar to the one described in Example 7, 200 mg (0.564 mmol) of 5-(4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 15) was converted to crude sulfonamide. Purification by silica gel chromatography gave 96 mg (48%) of 4-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: ^1H NMR (CDCl_3) δ 0.67 (s, 4H), 2.90 (s, 4H), 3.78 (s, 3H), 4.86 (br s, 2H), 6.76 (d, $J = 8.9$ Hz, 2H), 7.08 (d, $J = 8.9$ Hz, 2H), 7.30 (d, $J = 8.5$ Hz, 2H), 7.73 (d, $J = 8.5$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{21}\text{NO}_3\text{S}$: 355.1242. Found: 355.1250. Anal. Calc'd for $[\text{C}_{20}\text{H}_{21}\text{NO}_3\text{S} + 0.6 \text{ H}_2\text{O}]$: C, 65.60; H, 6.11; N, 3.82. Found: C, 65.59; H, 5.85; N, 3.66.

Example 18



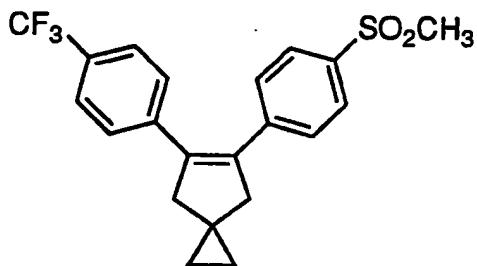
20

4-[6-(3-Bromo-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

Following a procedure similar to the one described in Example 7, 3 g (6.92 mmol) of 5-(3-bromo-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 16) was converted to crude sulfonamide. Purification by silica gel chromatography gave 1.32 g (44%) of 4-[6-(3-bromo-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 187.5-189.8 °C; ^1H NMR (CDCl_3) δ 0.67 (s, 4H), 2.89 (s, 4H), 3.87 (s, 3H), 4.76 (br s, 2H), 6.73 (d, $J = 8.5$ Hz, 1H), 7.0 (dd, $J = 2.1, 8.5$ Hz, 1H), 7.30

(d, δ = 8.7 Hz, 2H), 7.37 (dd, δ = 2.1 Hz, 1H), 7.76 (d, δ = 8.7 Hz, 2H). HRMS (EI) Calc'd for C₂₀H₂₀BrNO₃S: 433.0347. Found: 433.0310. Anal. Calc'd for C₂₀H₂₀BrNO₃S: C, 55.31; H, 4.64; N, 3.22. Found: C, 55.31; H, 4.77; N, 2.93.

Example 19

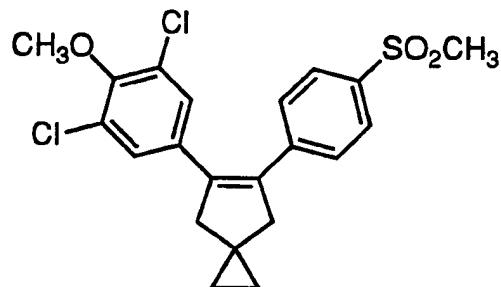


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6-[4-(Methylsulfonyl)phenyl]-5-(4-trifluoromethylphenyl)spiro[2.4]hept-5-ene

Following a procedure similar to the one
15 described in Example 6, with the substitution of 4-trifluoromethylacetophenone [prepared by the addition of methyllithium to α,α,α -trifluoro-p-tolunitrile (Aldrich), see Example 6, Step 1] for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 6-[4-(methylsulfonyl)phenyl]-5-(4-trifluoromethylphenyl)spiro[2.4]hept-5-ene was prepared as a white solid: mp 170.0-170.8 °C; ¹H NMR (CDCl₃) δ 0.70 (s, 4H), 2.95 (s, 4H), 3.05 (s, 3H), 7.24 (d, δ = 8.4 Hz, 2H), 7.31 (d, δ = 8.3 Hz, 2H), 7.49 (d, δ = 8.1 Hz, 2H), 20 7.78 (d, δ = 8.2 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₁₉F₃O₂S: 392.1058. Found: 392.1080. Anal. Calc'd for C₂₁H₁₉F₃O₂S: C, 64.27; H, 4.88; F, 14.52; S, 8.17. Found: C, 63.98; H, 4.90; F, 14.65; S, 8.33.

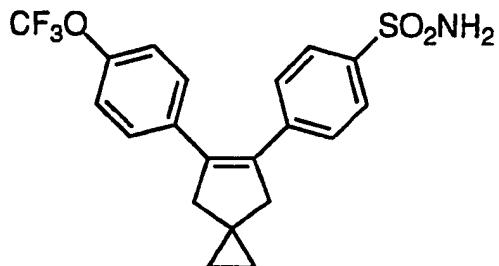
Example 20



5 5-(3,5-Dichloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Under nitrogen, a mixture of 0.2 g (0.49 mmol) of 2,6-dichloro-4-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]phenol (the title compound of Example 13), 91 μL (1.5 mmol) of iodomethane and 0.32 g (1 mmol) of cesium carbonate in 6 mL of DMF was stirred at 25 °C for 16 hours. The reaction mixture was diluted in ethyl acetate, washed with water, brine, dried (MgSO_4) and concentrated in vacuo. The residue was recrystallized to give 0.18 g (90%) of 5-(3,5-dichloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene as a white solid: mp 107.0-108.0 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.89 (d, $J = 14$ Hz, 4H), 3.05 (s, 3H), 3.89 (s, 3H), 7.04 (s, 2H), 7.34 (d, $J = 8.7$ Hz, 2H), 7.82 (d, $J = 8.4$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{21}\text{H}_{20}\text{Cl}_2\text{O}_3\text{S}$: 422.0510. Found: 422.0513. Anal. Calc'd for [$\text{C}_{21}\text{H}_{20}\text{Cl}_2\text{O}_3\text{S} + 0.67\text{H}_2\text{O}$]: C, 57.92; H, 4.94; Cl, 16.28; S, 7.36. Found: C, 57.79; H, 4.73; Cl, 16.68; S, 7.31.

Example 21

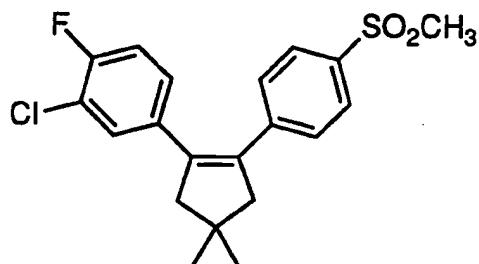


5 **4-[6-(4-Trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide**

Following a procedure similar to the one described in Example 7, 1.80 g (4.4 mmol) of 6-[4-(methylsulfonyl)phenyl]-5-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-ene (the title compound of Example 14) was converted to crude sulfonamide. Purification by silica gel chromatography gave 0.73 g (40%) of 4-[6-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 144.0-145.0 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.92 (s, 4H), 4.78 (br s, 2H), 7.08 (d, $J = 8.9$ Hz, 2H), 7.16 (d, $J = 9.0$ Hz, 2H), 7.28 (d, $J = 8.7$ Hz, 2H), 7.76 (d, $J = 8.7$ Hz, 2H).
 10 HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{18}\text{F}_3\text{NO}_3\text{S}$: 409.0960. Found: 409.0974. Anal. Calc'd for [$\text{C}_{20}\text{H}_{18}\text{F}_3\text{NO}_3\text{S} + 0.29 \text{ C}_3\text{H}_6\text{O}_2$]: C, 58.17; H, 4.62; N, 3.25; F, 13.23; S, 7.44. Found: C, 58.57; H, 4.47; N, 3.29; F, 12.62; S, 7.92.
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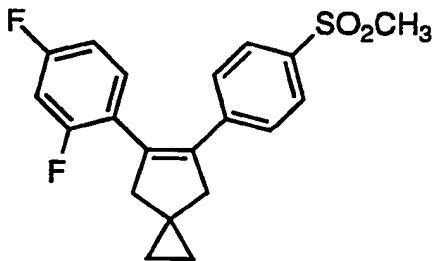
Example 22



5-(3-Chloro-4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one
 5 described in Example 6, with the substitution of 3'-chloro-4'-fluoroacetophenone (Lancaster) for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3-chloro-4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 128.0-130.0 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.91 (d, $J = 3.6$ Hz, 4H), 3.05 (s, 3H), 6.9-7.02 (m, 2H), 7.19 (d, $J = 7.5$ Hz, 1H), 7.33 (d, $J = 8.4$ Hz, 2H), 7.79 (d, $J = 8.7$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{18}\text{ClFO}_2\text{S}$: 376.0700. Found: 376.0710.
Anal. Calc'd for $\text{C}_{20}\text{H}_{18}\text{ClFO}_2\text{S}$: C, 63.74; H, 4.81; F, 5.04;
 10 Cl, 9.41; S, 8.51. Found: C, 63.61; H, 4.85; F, 4.70; Cl,
 15 9.58; S, 8.66.

Example 23



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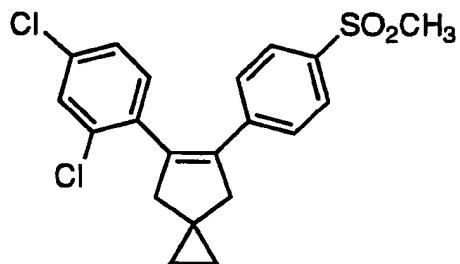
5-(2,4-Difluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one
 25 described in Example 6, with the substitution of 2-chloro-2',4'-difluoroacetophenone (Aldrich) for 2-bromo-(3'-chloro-4'-methoxy)acetophenone (Example 6, Step 8), 5-(2,4-difluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 116.0-117.5 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.89 (s, 2H), 2.94 (s, 2H), 3.03 (s, 3H), 6.78 (t, $J = 8.4$ Hz, 2H), 7.05 (q, $J = 6.6$ Hz, 2H), 7.28 (d, J

= 8.1 Hz, 2H), 7.74 (dd, $\underline{\Delta}$ = 1.8, 6.9 Hz, 2H). HRMS (EI) Calc'd for C₂₀H₁₈F₂O₂S: 360.0996. Found: 360.1010. Anal. Calc'd for [C₂₀H₁₈F₂O₂S + 0.22 H₂O]: C, 65.93; H, 5.10; S, 8.80. Found: C, 66.18; H, 5.16; S, 8.97.

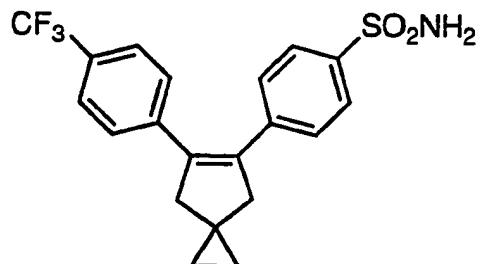
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Example 24



10 5-(2,4-Dichlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 2,2'4'-trichloroacetophenone (Aldrich) for 2-bromo-(3'-chloro-4'-methoxy)acetophenone (Example 6, Step 8), 5-(2,4-dichlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 90.0-91.5 °C; ¹H NMR (CDCl₃) δ 0.69 (s, 4H), 2.85 (s, 2H), 2.95 (s, 2H), 3.01 (s, 3H), 7.02 (d, $\underline{\Delta}$ = 8.1 Hz, 1H), 7.16 (d, $\underline{\Delta}$ = 2.1 Hz, 1H), 7.20 (d, $\underline{\Delta}$ = 8.4 Hz, 2H), 7.42 (d, $\underline{\Delta}$ = 2.1 Hz, 1H), 7.72 (d, $\underline{\Delta}$ = 8.7 Hz, 2H). HRMS (EI) Calc'd for C₂₀H₁₈Cl₂O₂S: 392.0405. Found: 392.0423. Anal. Calc'd for [C₂₀H₁₈Cl₂O₂S + 0.36 H₂O + 0.05 C₆H₁₄]: C, 60.31; H, 4.84; Cl, 17.56; S, 7.94. Found: C, 60.33; H, 4.53; Cl, 17.21; S, 8.32.

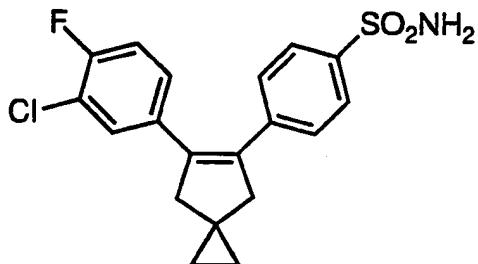
Example 25

5 **4-[6-(4-Trifluoromethylphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide**

Following a procedure similar to the one described in Example 7, 1.81 g (4.6 mmol) of 6-[4-(methylsulfonyl)phenyl]-5-(4-trifluoromethylphenyl)spiro[2.4]hept-5-ene (the title compound of Example 19) was converted to crude sulfonamide. Purification by silica gel chromatography gave 1.20 g (66%) of 4-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 157.2-188.8 °C; ^1H NMR (CDCl_3) δ 0.70 (s, 4H), 2.94 (s, 4H), 4.80 (s, 2H), 7.21-7.30 (m, 4H), 7.48 (d, $J = 8.5$ Hz, 2H), 7.77 (d, $J = 8.3$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{18}\text{F}_3\text{NO}_2\text{S}$: 393.1010. Found: 393.1045. Anal. Calc'd for [$\text{C}_{20}\text{H}_{18}\text{F}_3\text{NO}_2\text{S} + 0.07 \text{CH}_2\text{Cl}_2$]: C, 60.38; H, 4.58; N, 3.51; S, 8.03. Found: C, 60.30; H, 4.69; N, 3.50; S, 8.44.

Example 26

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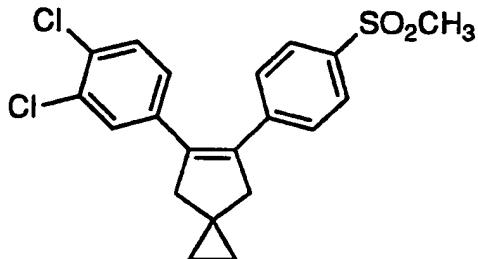


4-[6-(3-Chloro-4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

Following a procedure similar to the one described in Example 7, 1.0 g (2.65 mmol) of 5-(3-chloro-4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 22) was converted to crude sulfonamide. Purification by silica gel chromatography gave 0.19 g (19%) of 4-[6-(3-chloro-4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 163.0-165.0 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.90 (d, $J = 2.7$ Hz, 4H), 4.75 (br s, 2H), 6.70-7.05 (m, 2H), 7.18-7.24 (m, 1H), 7.24-7.32 (m, 3H), 7.78 (d, $J = 8.7$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{19}\text{H}_{17}\text{ClFNO}_2\text{S}$: 377.0652. Found: 377.0639. Anal. Calc'd for $[\text{C}_{19}\text{H}_{17}\text{ClFNO}_2\text{S} + 0.018 \text{CH}_2\text{Cl}_2]$: C, 60.21; H, 4.53; N, 3.69; F, 5.01; Cl, 9.68; S, 8.45. Found: C, 60.49; H, 4.63; N, 3.50; F, 4.91; Cl, 9.86; S, 8.61.

Example 27

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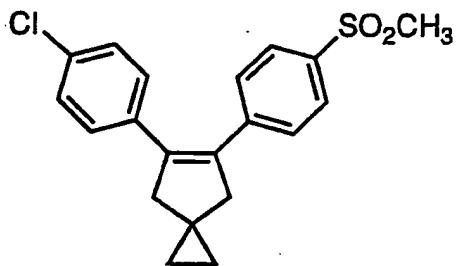
5-(3,4-Dichlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

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Following a procedure similar to the one described in Example 6, with the substitution of 2-bromo-(3',4'-dichloro)acetophenone (Lancaster) for 2-bromo-(3'-chloro-4'-methoxy)acetophenone (Example 6, Step 8), 5-(3,4-dichlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 107.5-108.5 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.91 (d, $J = 3.0$ Hz, 4H), 3.05 (s, 3H), 6.90 (dd,

$J = 1.9, 8.7$ Hz, 1H), 7.24 (d, $J = 2.1$ Hz, 1H), 7.27 (d, $J = 8.7$ Hz, 1H), 7.33 (d, $J = 8.4$ Hz, 2H), 7.80 (d, $J = 8.4$ Hz, 2H). MS (FAB): m/z 399 (100, M+Li). Anal. Calc'd for [C₂₀H₁₈Cl₂O₂S + 0.08 C₆H₁₄]: C, 61.45; H, 4.81; Cl, 17.72; S, 8.02. Found: C, 61.28; H, 4.73; Cl, 17.33; S, 8.30.

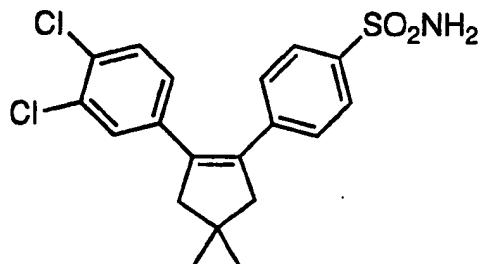
Example 28



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5-(4-Chlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one
15 described in Example 6, with the substitution of 2-bromo-
4'-chloroacetophenone (Aldrich) for 2-bromo-(3'-chloro-4'-
methoxy)acetophenone (Example 6, Step 8), 5-(4-
chlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-
5-ene was prepared as a white solid: mp 143.0-145.0 °C; ¹H
20 NMR (CDCl₃) δ 0.69 (s, 4H), 2.92 (s, 4H), 3.05 (s, 3H),
7.07 (d, $J = 8.7$ Hz, 2H), 7.21 (d, $J = 8.7$ Hz, 2H), 7.33
(d, $J = 8.4$ Hz, 2H), 7.77 (dd, $J = 8.7$ Hz, 2H). MS
(FAB): m/z 365 (100, M+Li) Anal. Calc'd for C₂₀H₁₉ClO₂S:
C, 66.94; H, 5.36; Cl, 9.88; S, 8.93. Found: C, 66.34; H,
25 S, 5.38; Cl, 9.96; S, 9.01.

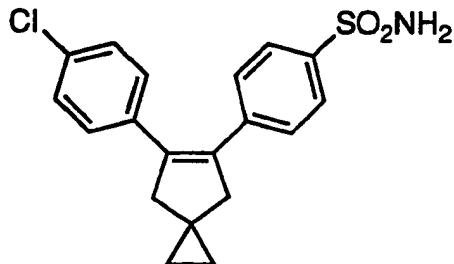
Example 29

5 **4-[6-(3,4-Dichlorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide**

Following a procedure similar to the one described in Example 7, 5.20 g (13.2 mmol) of 5-(3,4-dichlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 27) was converted to crude sulfonamide. Purification by silica gel chromatography gave 1.40 g (27%) of 4-[6-(3,4-dichlorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 162.0-163.0 °C; ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.90 (d, $J = 2.1$ Hz, 4H), 4.77 (s, 2H), 6.92 (dd, $J = 2.1, 8.4$ Hz, 1H), 7.23-7.32 (m, 4H), 7.78 (d, $J = 8.7$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{19}\text{H}_{17}\text{Cl}_2\text{NO}_2\text{S}$: 393.0357. Found: 393.0354. Anal. Calc'd for [$\text{C}_{19}\text{H}_{17}\text{Cl}_2\text{NO}_2\text{S} + 0.035\text{C}_6\text{H}_14$]: C, 58.07; H, 4.44; N, 3.52; Cl, 17.84; S, 8.07. Found: C, 58.15; H, 4.41; N, 3.43; Cl, 17.59; S, 8.88.

Example 30

25

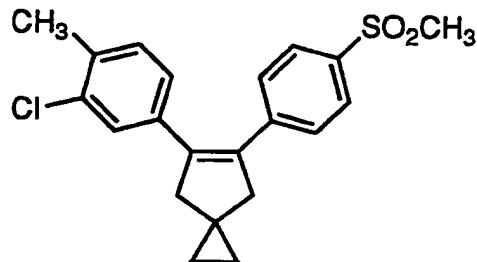


4-[6-(4-Chlorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

Following a procedure similar to the one described in Example 7, 7.5 g (20.9 mmol) of 5-(4-chlorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 28) was converted to crude sulfonamide. Purification by silica gel chromatography gave 2.82 g (37%) of 4-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 152.5-153.5 °C; ¹H NMR (CDCl₃) δ 0.68 (s, 4H), 2.91 (s, 4H), 4.85-5.05 (br s, 2H), 7.07 (d, J = 8.4 Hz, 2H), 7.20 (d, J = 8.4 Hz, 2H), 7.27 (d, J = 8.1 Hz, 2H), 7.75 (d, J = 8.4 Hz, 2H). HRMS (EI) Calc'd for C₁₉H₁₈ClNO₂S: 359.0747. Found: 359.0747. Anal. Calc'd for C₁₉H₁₈ClNO₂S: C, 63.41; H, 5.04; Cl, 9.85; N, 3.89; S, 8.91. Found: C, 63.47; H, 5.12; Cl, 10.21; N, 3.78; S, 8.98.

Example 31

20



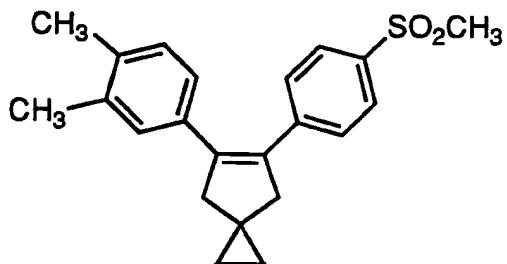
5-(3-Chloro-4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 3'-chloro-4'-methoxyacetophenone [prepared by the addition of methyllithium to 3-chloro-4-methylbenzonitrile (Aldrich), see Example 6, Step 1] for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3-chloro-4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 142-144 °C; ¹H NMR (CDCl₃) δ 0.68 (s, 4H), 2.33 (s, 3H) 2.90 (d, J = 2.1 Hz,

4H), 3.04 (s, 3H), 6.88 (dd, J = 1.5, 7.5 Hz, 1H), 7.06 (d, J = 7.5 Hz, 1H), 7.14 (d, J = 1.5 Hz, 1H), 7.34 (d, J = 8.7 Hz, 2H), 7.78 (d, J = 8.7 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₂₁ClO₂S: 372.0951. Found: 372.0922. Anal.
 5 Calc'd for C₂₁H₂₁ClO₂S: C, 67.58; H, 5.63; S, 8.58.
 Found: C, 67.47; H, 5.86; S, 8.52.

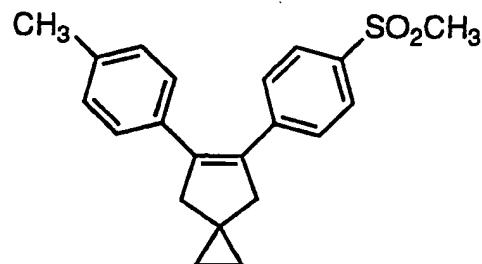
Example 32

10



5-(3,4-Dimethylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

15 Following a procedure similar to the one described in Example 6, with the substitution of 3',4'-dimethylacetophenone (Aldrich) for 3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3,4-dimethylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 95-96.5 °C; ¹H NMR (CDCl₃) δ 0.67 (s, 4H), 2.17 (s, 3H), 2.23 (s, 3H), 2.91 (s, 4H), 3.03 (s, 3H), 6.82-6.87 (m, 1H), 6.91-7.01 (m, 2H), 7.35 (d, J = 8.7 Hz, 2H), 7.74 (d, J = 8.7 Hz, 2H). HRMS (EI) Calc'd for C₂₂H₂₄O₂S: 352.1497. Found: 352.1496. Anal. Calc'd for C₂₂H₂₄O₂S: C, 74.89; H, 6.81; S, 9.08. Found: C, 74.45; H, 6.96; S, 8.93.

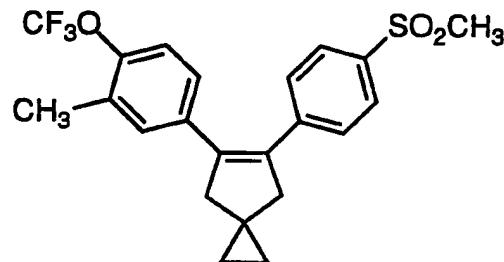
Example 33

5

5-(4-Methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 2-bromo-4'-methylacetophenone (Aldrich) for 2-bromo-(3'-chloro-4'-methoxy)acetophenone (Example 6, Step 8), 5-(4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 146-148 °C; ¹H NMR (CDCl₃) δ 0.67 (s, 4H), 2.32 (s, 3H), 2.91 (s, 4H), 3.03 (s, 3H), 7.04 (s, 4H), 7.34 (d, J = 8.7 Hz, 2H), 7.74 (d, J = 8.7 Hz, 2H). HRMS (EI) Calc'd for C₂₁H₂₂O₂S: 338.1341. Found: 338.1323. Anal. Calc'd for C₂₁H₂₂O₂S: C, 74.45; H, 6.50; S, 9.45. Found: C, 73.90; H, 6.64; S, 9.31.

20

Example 34

25

5-(3-Methyl-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Step 1: Preparation of 4-(trifluoromethoxy)acetophenone

Under nitrogen, to a stirred solution of 66 g (353 mmol) of 4-(trifluoromethoxy)benzonitrile (Aldrich) in 600 mL of anhydrous THF at -78 °C was added 303 mL (424 mmol) of methylolithium (1.4 M in diethyl ether, Aldrich). After stirred for three hours, the solution was warmed to room temperature. A 300 mL of 3 N HCl was added, and stirring was continued overnight. The THF was removed in vacuo, and the resulting solution was extracted twice with ethyl acetate. The ethyl acetate extracts were combined, washed with water, brine, and dried over MgSO₄. Concentration of solvent in vacuo gave 63.9 g (89%) of the 4-(trifluoromethoxy)acetophenone as a dark brown oil: ¹H NMR (CDCl₃) δ 2.61 (s, 3H), 7.29 (d, J = 9 Hz, 2H), 8.01 (d, J = 9 Hz, 2H).

Step 2: Preparation of ketal

Under nitrogen, to a stirred solution of 63.9 g (313 mmol) of 4-(trifluoromethoxy)acetophenone (prepared in Step 1) in 200 mL of toluene in a 500 mL round bottom flask fitted with a Dean-Stark trap was added 65.2 g (626 mmol) of neopentyl glycol (Aldrich) and 1.3 g of *p*-toluenesulfonic acid monohydrate (Aldrich). After stirring overnight at reflux, the solution was cooled to room temperature and concentrated in vacuo. The residue was dissolved in diethyl ether, washed with 2 M NaHCO₃, and dried over MgSO₄. Purification by silica gel plug with triethylamine/hexane (1:99) as the eluent gave 79.7 g (88%) of the ketal as a brown oil: ¹H NMR (CDCl₃) δ 0.59 (s, 3H), 1.25 (s, 3H), 1.51 (s, 3H), 3.38 (s, 4H), 7.22 (d, J = 9 Hz, 2H), 7.45 (d, J = 9 Hz, 2H).

Step 3: Metallation of the ketal

35

Under nitrogen, to a stirred solution of 79.7 g (275 mmol) of the ketal (prepared in Step 2) in 511 mL of

dry hexane was added 114 mL (545 mmol) of TMEDA (N, N, N', N'-tetramethylethylenediamine). After cooling to -78 °C, the solution was treated with 582 mL (757 mmol) of sec-butyllithium (1.3 M in cyclohexane, Aldrich), and stirred 5 vigorously for five hours at -78 °C. To this solution was added 51.4 mL (826 mmol) of iodomethane and stirred for one hour. After warming to room temperature, the reaction was quenched with 2 N HCl, and extracted with diethyl ether. The diethyl ether extracts were combined, washed 10 with 2 N HCl, and dried over MgSO₄. Concentration of the solvent in vacuo gave 74 g of the ketal of 3'-methyl-4'-(trifluoromethoxy)acetophenone as a brown oil, and was used for next step without further purification.

15 Step 4: Preparation of 3-methyl-4-(trifluoromethoxy)acetophenone

Under nitrogen, to a stirred solution of 74 g of the crude oil (prepared in Step 3) in 200 mL of acetone 20 and 10 mL of water was added 130 g (683 mmol) of *p*-toluenesulfonic acid monohydrate (Aldrich). After stirring overnight, the solution was concentrated in vacuo, and the residue was dissolved in ethyl acetate. The ethyl acetate layer was washed with 2 N NaHCO₃, and 25 dried over MgSO₄. Purification by silica gel plug with ethyl acetate/ hexane (10:90) as the eluent gave 31.9 g (53% for both Steps 3 and 4) of 3-methyl-4-(trifluoromethoxy)acetophenone as a yellow oil: ¹H NMR (CDCl₃) δ 2.37 (s, 3H), 2.59 (s, 3H), 7.27 (d, J = 8 Hz, 30 1H), 7.81 (d, J = 8 Hz, 1H), 7.86 (s, 1H).

Step 5: Preparation of 5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

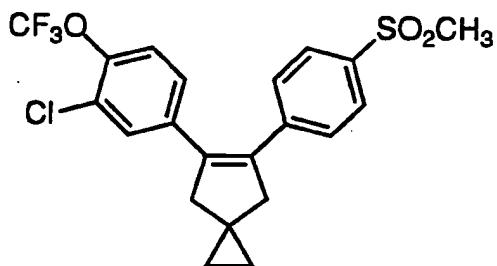
35

Following a procedure similar to the one described in Example 6 with the substitution of 3'-methyl-4'-(trifluoromethoxy)acetophenone (prepared in Step 4) for

3'-chloro-4'-methoxyacetophenone (Example 6, Step 7), 5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 79.1-80.3 °C. MS (FAB): m/z 429 (M+Li). ^1H NMR (CDCl_3) δ 0.69 (s, 4H), 2.22 (s, 3H), 2.92 (s, 4H), 3.04 (s, 3H), 6.91-6.97 (m, 1H), 7.03-7.08 (m, 2H), 7.34 (d, $J = 8$ Hz, 2H), 7.77 (d, $J = 8$ Hz, 2H). Anal. Calc'd for $C_{22}\text{H}_{21}\text{F}_3\text{O}_3\text{S}$: C, 62.55; H, 5.01; F, 13.49. Found: C, 62.29; H, 4.93; F, 13.49.

10

Example 35



15 5-(3-Chloro-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Step 1: Preparation of 3-chloro-4-(trifluoromethoxy)benzoic acid

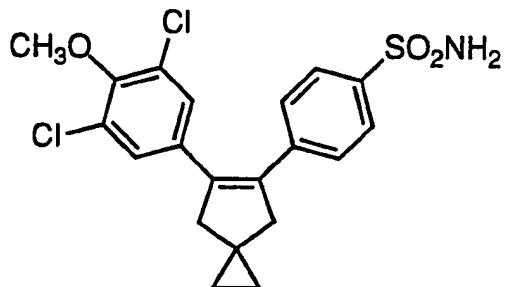
20

A dried, 750-mL Parr reactor (steel) equipped with a sealed mechanical stirrer and an internal thermocouple was charged with 54.2 g (0.314 mol) of 3-chloro-4-hydroxybenzoic acid, 125.5 mL (1.3 mol) of carbon tetrachloride, 172 g (0.965 mol) of anhydrous antimony trifluoride, and 7.55 g (0.025 mol) of antimony pentachloride. The reactor was sealed and heated at 150 °C with stirring for 4 hours. After cooling, the reactor was opened and the contents were neutralized with saturated NaHCO_3 and 50% NaOH , then adjusted down to pH 1 with concentrated HCl . The mixture was filtered, and the aqueous filtrate was separated and extracted with 500 mL of ethyl acetate. The combined extracts were extracted

with dilute NaOH solution (pH = 11). To the aqueous extract was added 200 mL of brine, and the mixture was extracted with ethyl acetate. The extract was concentrated in vacuo, and the residue was treated with 5 250 mL of methanol and 290 mL (720 mmol) of 2.5 N NaOH and stirred at ambient temperature for 22 hours. The reaction mixture was treated with conc. HCl to pH 1, extracted with ethyl acetate, dried ($MgSO_4$), and concentrated in vacuo to give 35.5 g (47%) of 3-chloro-4-
10 (trifluoromethoxy)benzoic acid as a white solid: 1H NMR ($CDCl_3$) δ 7.69 (d, J = 8.7 Hz, 1H), 8.03 (dd, J = 1.8, 8.7 Hz, 1H), 8.13 (d, J = 1.5 Hz, 1H).

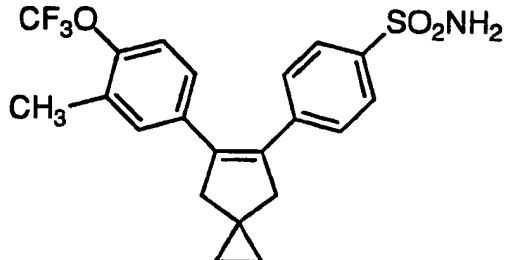
15 Step 2: Preparation of 5-(3-chloro-4-
trifluoromethoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene

Following a procedure similar to the one described in Example 6, with the substitution of 3-chloro-
20 4-(trifluoromethoxy)benzoic acid (prepared in Step 1) for 3-chloro-4-methoxybenzoic acid (Example 6, Step 5), 5-(3-chloro-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene was prepared as a white solid: mp 104-105.5 °C; 1H NMR ($CDCl_3$) δ 0.69
25 (s, 4H), 2.92 (br d, J = 2.7 Hz, 4H), 3.05 (s, 3H), 7.00 (dd, J = 2.1, 8.4 Hz, 1H), 7.16 (dd, J = 1.2, 8.7 Hz, 1H), 7.25 (s, 1H), 7.33 (d, J = 8.4 Hz, 2H), 7.81 (d, J = 8.7 Hz, 2H). HRMS (EI) Calc'd for $C_{21}H_{18}ClF_3O_3S$: 442.0617. Found: 442.0617. Anal. Calc'd for $C_{21}H_{18}ClF_3O_3S$: C, 56.95; H, 4.10; Cl, 8.01; F, 12.87; S, 7.24. Found: C, 57.10; H, 4.15; Cl, 7.74; F, 12.55; S, 7.48.

Example 36

5 **4-[6-(3,5-Dichloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide**

Following a procedure similar to the one described in Example 7, with the substitution of 10 butyllithium instead of propylmagnesium chloride, 423 mg (1 mmol) of 5-(3,5-dichloro-4-methoxy-phenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 20) was converted to crude sulfonamide. Purification by silica gel chromatography 15 gave 87 mg (15%) of 4-[6-(3,5-dichloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 94.5-97.0 °C (decomp); ¹H NMR (CDCl_3) δ 0.68 (s, 4H), 2.83-2.95 (m, 4H), 3.89 (s, 3H), 4.81 (br s, 2H), 7.05 (s, 2H), 7.29 (d, $J = 8.5$ Hz, 2H), 7.80 (d, $J = 8.6$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{19}\text{Cl}_2\text{NO}_3\text{S}$: 423.0463. Found: 423.0455.

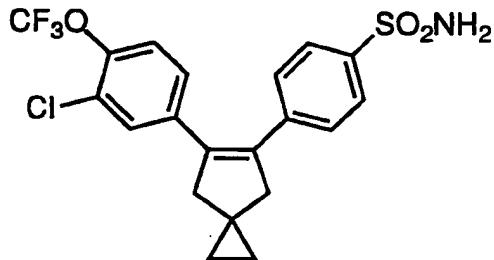
Example 37

4-[6-(3-Methyl-4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

5 Following a procedure similar to the one described in Example 7, 470 mg (1.16 mmol) of 5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 34) was converted to crude 10 sulfonamide. Purification by silica gel chromatography (MPLC) gave 70 mg (14%) of 4-[6-(3-methyl-4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 136-137 °C. MS (FAB): m/z 430 (M+Li). ^1H NMR (CDCl_3) δ 0.68 (s, 4H), 15 2.22 (s, 3H), 2.91 (s, 4H), 4.71 (s, 2H), 6.92-6.97 (m, 1H), 7.02-7.07 (m, 2H), 7.29 (d, $J = 8$ Hz, 2H), 7.75 (d, $J = 8$ Hz, 2H). Anal. Calc'd for $\text{C}_{21}\text{H}_{20}\text{F}_3\text{NO}_3\text{S}$: C, 59.57; H, 4.76; N, 3.31. Found: C, 59.75; H, 4.88; N, 3.17.

20

Example 38



25

4-[6-(3-Chloro-4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide

30

Following a procedure similar to the one described in Example 7, 0.50 g (1.13 mmol) of 5-(3-chloro-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene (the title compound of Example 35) was converted to crude sulfonamide. Purification by silica gel chromatography

gave 0.39 g (78%) of 4-[6-(3-chloro-4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide as a white solid: mp 125.0-128.0 °C; ^1H NMR (CDCl_3) δ 0.62 (s, 4H), 2.84 (s, 4H), 4.71 (br s, 2H), 6.94 (dd, $J = 2.1, 8.4$ Hz, 1H), 7.08 (dd, $J = 1.2, 8.7$ Hz, 1H), 7.14-7.26 (m, 3H), 7.72 (d, $J = 8.7$ Hz, 2H). HRMS (EI) Calc'd for $\text{C}_{20}\text{H}_{17}\text{ClF}_3\text{NO}_3\text{S}$: 443.0570. Found: 443.0603.

10

BIOLOGICAL EVALUATION

Rat Carrageenan Foot Pad Edema Test

The carrageenan foot edema test was performed
15 with materials, reagents and procedures essentially as described by Winter, et al., (Proc. Soc. Exp. Biol. Med., 111, 544 (1962)). Male Sprague-Dawley rats were selected in each group so that the average body weight was as close as possible. Rats were fasted with free access to
20 water for over sixteen hours prior to the test. The rats were dosed orally (1 mL) with compounds suspended in vehicle containing 0.5% methylcellulose and .025% surfactant, or with vehicle alone. One hour later a subplantar injection of 0.1 mL of 1% solution of
25 carrageenan/sterile 0.9% saline was administered and the volume of the injected foot was measured with a displacement plethysmometer connected to a pressure transducer with a digital indicator. Three hours after the injection of the carrageenan, the volume of the foot
30 was again measured. The average foot swelling in a group of drug-treated animals was compared with that of a group of placebo-treated animals and the percentage inhibition of edema was determined (Otterness and Bliven, Laboratory Models for Testing NSAIDs, in Non-steroidal Anti-Inflammatory Drugs, (J. Lombardino, ed. 1985)). Results
35 are shown in Table I.

Rat Carrageenan-induced Analgesia Test

The rat carrageenan analgesia test was performed with materials, reagents and procedures 5 essentially as described by Hargreaves, et al., (Pain, 32, 77 (1988)). Male Sprague-Dawley rats were treated as previously described for the Carrageenan Foot Pad Edema test. Three hours after the injection of the 10 carrageenan, the rats were placed in a special plexiglass container with a transparent floor having a high intensity lamp as a radiant heat source, positionable under the floor. After an initial twenty minute period, thermal stimulation was begun on either the injected foot or on the contralateral uninjected foot. A photoelectric 15 cell turned off the lamp and timer when light was interrupted by paw withdrawal. The time until the rat withdraws its foot was then measured. The withdrawal latency in seconds was determined for the control and drug-treated groups, and percent inhibition of the 20 hyperalgesic foot withdrawal determined. Results are shown in Table I.

TABLE I.

	RAT PAW EDEMA % Inhibition @ 10mg/kg body weight	ANALGESIA % Inhibition @ 10mg/kg body weight
5 Examples		
1	32	15
2	57	34
3	24	-
10 4	17	-
6	21	7
7	20	18
8	15	8
9	15	17
15 14	18	-
16	6	-
19	11	9
20	24	28
22	21	10
20 25	34	22
27	15	-
29	24	29

25 Evaluation of COX-1 and COX-2 activity in vitroa. Preparation of recombinant COX baculoviruses

Recombinant COX-1 and COX-2 were prepared as described by Gierse et al, [J. Biochem., 305, 479-84 (1995)]. A 2.0 kb fragment containing the coding region of either human or murine COX-1 or human or murine COX-2 was cloned into a BamH1 site of the baculovirus transfer vector pVL1393 to generate the baculovirus transfer vector. Recombinant baculoviruses were isolated by transfecting 4 µg of baculovirus transfer vector DNA into SF9 cells (2×10^8) along with 200 ng of linearized baculum

phosphate method. Recombinant viruses were purified by three rounds of plaque purification and high titer (10^7 - 10^8 pfu/ml) stocks of virus were prepared. For large scale production, SF9 insect cells were infected in 10 5 liter fermentors (0.5×10^6 /ml) with the recombinant baculovirus stock such that the multiplicity of infection was 0.1. After 72 hours the cells were centrifuged and the cell pellet homogenized in Tris/Sucrose (50 mM: 25%, pH 8.0) containing 1% CHAPS. The homogenate was 10 centrifuged at 10,000xG for 30 minutes, and the resultant supernatant was stored at -80°C before being assayed for COX activity.

b. Assay for COX I and COX II activity:

15 COX activity was assayed as PGE₂ formed/ μ g protein/time using an ELISA to detect the prostaglandin released. CHAPS-solubilized insect cell membranes containing the appropriate COX enzyme were incubated in a 20 potassium phosphate buffer (50 mM, pH 8.0) containing epinephrine, phenol, and heme with the addition of arachidonic acid (10 μ M). Compounds were pre-incubated with the enzyme for 10-20 minutes prior to the addition of arachidonic acid. Any reaction between the 25 arachidonic acid and the enzyme was stopped after ten minutes at 37°C/room temperature by transferring 40 μ l of reaction mix into 160 μ l ELISA buffer and 25 μ M indomethacin. The PGE₂ formed was measured by standard 30 ELISA technology (Cayman Chemical). Results are shown in Table II.

TABLE II.

		COX I <u>ID₅₀ μM</u>	COX II <u>ID₅₀ μM</u>
5	Examples		
	1	14	<0.1
	2	0.2	<0.1
	3	>100	<0.1
	4	0.9	<0.1
10	5	>100	<0.1
	6	>100	<0.1
	7	1.8	<0.1
	8	>100	<0.1
	9	.5	<0.1
15	10	>100	<0.1
	11	1.4	<0.1
	12	0.9	<0.1
	13	>100	4.8
	14	>100	0.1
20	15	0.6	<0.1
	16	59	<0.1
	17	<0.1	<0.1
	18	0.4	<0.1
	19	>100	<0.1
25	20	>100	<.1
	21	1.8	0.1
	22	6.0	<0.1
	23	0.7	<0.1
	24	>100	<0.1
30	25	0.4	<0.1
	26	0.3	<0.1
	27	>100	<0.1
	28	3.1	<0.1
	29	0.4	<0.1
35	30	0.1	<0.1
	31	>100	<0.1
	32	>100	<0.1

TABLE II (cont.).

	COX I <u>ID₅₀ μM</u>	COX II <u>ID₅₀ μM</u>
5		
33	4.0	<0.1
34	>100	<0.1
36	16.4	<0.1
37	20.6	<0.1
10	38	0.3

Also embraced within this invention is a class of pharmaceutical compositions comprising one or more 15 compounds of Formula I in association with one or more non-toxic, pharmaceutically-acceptable carriers and/or diluents and/or adjuvants (collectively referred to herein as "carrier" materials) and, if desired, other active ingredients. The compounds of the present 20 invention may be administered by any suitable route, preferably in the form of a pharmaceutical composition adapted to such a route, and in a dose effective for the treatment intended. The compounds and composition may, for example, be administered intravascularly, 25 intraperitoneally, subcutaneously, intramuscularly or topically.

For oral administration, the pharmaceutical 30 composition may be in the form of, for example, a tablet, capsule, suspension or liquid. The pharmaceutical composition is preferably made in the form of a dosage unit containing a particular amount of the active ingredient. Examples of such dosage units are tablets or capsules. The active ingredient may also be administered 35 by injection as a composition wherein, for example, saline, dextrose or water may be used as a suitable carrier.

The amount of therapeutically active compound that is administered and the dosage regimen for treating a disease condition with the compounds and/or

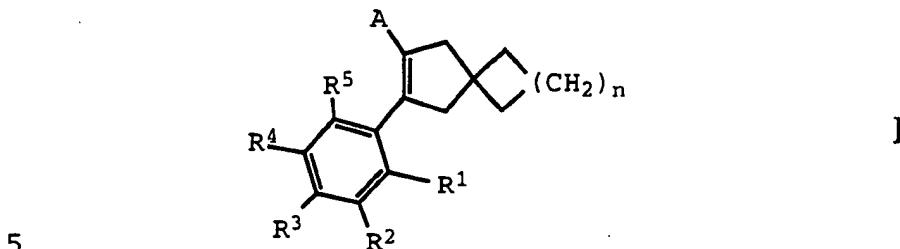
- 5 compositions of this invention depends on a variety of factors, including the age, weight, sex and medical condition of the subject, the severity of the disease, the route and frequency of administration, and the particular compound employed, and thus may vary widely.
- 10 The pharmaceutical compositions may contain active ingredient in the range of about 0.1 to 2000 mg, preferably in the range of about 0.5 to 500 mg and most preferably between about 1 and 100 mg. A daily dose of about 0.01 to 100 mg/kg body weight, preferably between
- 15 about 0.1 and about 50 mg/kg body weight and most preferably between about 1 to 20 mg/kg body weight, may be appropriate. The daily dose can be administered in one to four doses per day.
- 20 For therapeutic purposes, the compounds of this invention are ordinarily combined with one or more adjuvants appropriate to the indicated route of administration. If administered per os, the compounds may be admixed with lactose, sucrose, starch powder,
- 25 cellulose esters of alkanoic acids, cellulose alkyl esters, talc, stearic acid, magnesium stearate, magnesium oxide, sodium and calcium salts of phosphoric and sulfuric acids, gelatin, acacia gum, sodium alginate, polyvinylpyrrolidone, and/or polyvinyl alcohol, and then
- 30 tableted or encapsulated for convenient administration. Such capsules or tablets may contain a controlled-release formulation as may be provided in a dispersion of active compound in hydroxypropylmethyl cellulose. Formulations for parenteral administration may be in the form of
- 35 aqueous or non-aqueous isotonic sterile injection solutions or suspensions. These solutions and suspensions may be prepared from sterile powders or

granules having one or more of the carriers or diluents mentioned for use in the formulations for oral administration. The compounds may be dissolved in water, polyethylene glycol, propylene glycol, ethanol, corn oil, 5 cottonseed oil, peanut oil, sesame oil, benzyl alcohol, sodium chloride, and/or various buffers. Other adjuvants and modes of administration are well and widely known in the pharmaceutical art.

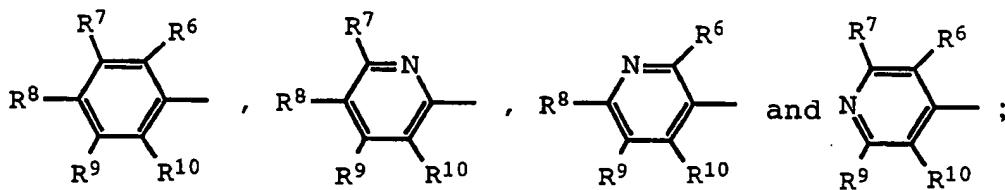
10 Although this invention has been described with respect to specific embodiments, the details of these embodiments are not to be construed as limitations.

What is claimed is:

1. A compound of Formula I



wherein A is selected from



10

wherein each of R¹ through R¹⁰, if present, is independently selected from hydrido, halo, alkyl, alkoxy, alkylthio, alkylamino, cyano, haloalkyl, haloalkoxy, hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto, alkylsulfonyl, haloalkylsulfonyl and aminosulfonyl; and wherein n is a number selected from 0, 1, 2 and 3; or a pharmaceutically-acceptable salt thereof.

20 2. Compound of Claim 1 wherein, if present, each of R¹, R², R⁴ through R⁷, R⁹ and R¹⁰ is independently selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and mercapto; and wherein R³ is selected from lower alkylsulfonyl, lower haloalkylsulfonyl and aminosulfonyl, and R⁸, if present, is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower alkylamino, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl,

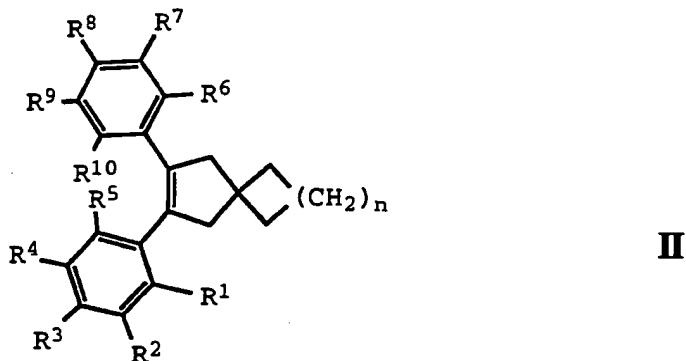
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lower alkoxyalkyl, hydroxyl and mercapto; or wherein further R⁸ and R⁹, if present, together form methylenedioxy; or wherein further, R³ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower
5 alkylthio, lower alkylamino, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and mercapto, and R⁸ is selected from lower alkylsulfonyl, lower haloalkylsulfonyl and aminosulfonyl; or wherein further R³ and R⁴, if present,
10 together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

3. Compound of Claim 2 wherein, if present, each of R¹, R², R⁴ through R⁷, R⁹ and R¹⁰ is
15 independently selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl,
20 chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, trifluoromethoxy, hydroxymethyl,
25 methoxymethyl and ethoxymethyl; and wherein R³ is selected from methylsulfonyl, fluoromethylsulfonyl, difluoromethylsulfonyl, trifluoromethylsulfonyl and aminosulfonyl, and R⁸, if present, is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-
30 propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, methylamino, N,N-dimethylamino, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl,
35 pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl,

dichloropropyl, trifluoromethoxy, hydroxymethyl, methoxymethyl and ethoxymethyl; or wherein further R⁸ and R⁹, if present, together form methylenedioxy; or wherein further R³ is selected from hydrido, fluoro, 5 chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, methylamino, N,N-dimethylamino, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, 10 chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, trifluoromethoxy, hydroxymethyl, 15 methoxymethyl and ethoxymethyl, and R⁸ is selected from methylsulfonyl, fluoromethylsulfonyl, difluoromethylsulfonyl, trifluoromethylsulfonyl and aminosulfonyl; or wherein further R³ and R⁴, if present, together form methylenedioxy; or a pharmaceutically- 20 acceptable salt thereof.

4. A compound of Formula II



25

wherein each of R¹ through R¹⁰ is independently selected from hydrido, halo, alkyl, alkoxy, alkylthio, alkylamino, cyano, haloalkyl, haloalkoxy, hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto, alkylsulfonyl, 30 haloalkylsulfonyl and aminosulfonyl; and wherein n is a

number selected from 0, 1, 2 and 3; or a pharmaceutically-acceptable salt thereof.

5. Compound of Claim 4 wherein n is a number
selected from 0, 1 and 2; wherein each of R¹, R² and R⁴
through R¹⁰ is independently selected from hydrido,
halo, lower alkyl, lower alkylthio, lower alkylamino,
cyano, lower haloalkyl, lower haloalkoxy, lower alkoxy,
hydroxyl, mercapto, lower hydroxyalkyl and lower
10 alkoxyalkyl; and wherein R³ is selected from lower
alkylsulfonyl, lower haloalkylsulfonyl and
aminosulfonyl; or wherein R⁸ and R⁹ together form
methylenedioxy; or a pharmaceutically-acceptable salt
thereof.

15

6. Compound of Claim 5 wherein each of R¹, R²
and R⁴ through R¹⁰ is independently selected from
hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-
propyl, isopropyl, butyl, tert-butyl, isobutyl,
20 methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto,
methylthio, ethylthio, methylamino, N,N-dimethylamino,
cyano, fluoromethyl, difluoromethyl, trifluoromethyl,
chloromethyl, dichloromethyl, trichloromethyl,
pentafluoroethyl, heptafluoropropyl,
25 difluorochloromethyl, dichlorofluoromethyl,
difluoroethyl, difluoropropyl, dichloroethyl,
dichloropropyl, trifluoromethoxy, hydroxymethyl,
methoxymethyl and ethoxymethyl; and wherein R³ is
selected from methylsulfonyl, fluoromethylsulfonyl,
30 difluoromethylsulfonyl, trifluoromethylsulfonyl and
aminosulfonyl; or wherein R⁸ and R⁹ together form
methylenedioxy; or a pharmaceutically-acceptable salt
thereof.

35

7. Compound of Claim 6 selected from
compounds, and their pharmaceutically-acceptable salts,
of the group consisting of

5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]-
1,3-benzodioxole;
2,6-dichloro-4-[6-[4-
5 (methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-
yl]phenol;
5-(4-trifluoromethoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-bromo-4-methoxyphenyl)-6-[4-
10 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
4-[6-(3-bromo-4-methoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
5-(3,5-dichloro-4-methoxy-phenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
15 4-[6-(4-trifluoromethoxyphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;
5-(2,4-difluorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(2,4-dichlorophenyl)-6-[4-
20 (methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-chloro-4-methylphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,4-dimethylphenyl)-6-[4-(
methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
25 5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-chloro-4-trifluoromethoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
4-[6-(3,5-dichloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-
30 yl]benzenesulfonamide;
4-[6-(3-methyl-4-trifluoromethoxyphenyl)spiro[2.4]hept-5-
en-5-yl]benzenesulfonamide;
4-[6-(3-chloro-4-trifluoromethoxyphenyl)spiro[2.4]hept-5-
en-5-yl]benzenesulfonamide;
35 5-phenyl-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-
ene;
5-(4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]

spiro[2.4]hept-5-ene;

5-(4-chlorophenyl)-6-[4-(methylsulfonyl)phenyl]
spiro[2.4]hept-5-ene;

5-(4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]

5 spiro[2.4]hept-5-ene;

5-(4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]
spiro[2.4]hept-5-ene;

5-(4-methylthiophenyl)-6-[4-(methylsulfonyl)phenyl]
spiro[2.4]hept-5-ene;

10 5-(4-cyanophenyl)-6-[4-(methylsulfonyl)phenyl]
spiro[2.4]hept-5-ene;

5-(4-trifluoromethylphenyl)-6-[4-(methylsulfonyl)
phenyl]spiro[2.4]hept-5-ene;

4-(6-phenylspiro[2.4]hept-5-en-5-yl)

15 benzenesulfonamide;

4-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

20 4-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(4-methylthiophenyl)spiro[2.4]hept-5-en-5-yl]

25 benzenesulfonamide;

4-[6-(4-cyanophenyl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;

4-[6-(4-trifluoromethylphenyl)spiro[2.4]hept-5-en-5-
yl]benzenesulfonamide;

30 6-phenyl-7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-
ene;

6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;

6-(4-chlorophenyl)-7-[4-(methylsulfonyl)phenyl]

35 spiro[3.4]oct-6-ene;

6-(4-methylphenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;

- 6-(4-methoxyphenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 6-(4-methylthiophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 5 6-(4-cyanophenyl)-7-[4-(methylsulfonyl)phenyl]
spiro[3.4]oct-6-ene;
- 6-(4-trifluoromethylphenyl)-7-[4-(methylsulfonyl)
phenyl]spiro[3.4]oct-6-ene;
- 4-(7-phenylspiro[3.4]oct-6-en-6-yl)benzenesulfonamide;
- 10 4-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]
15 benzenesulfonamide;
- 4-[7-(4-methoxyphenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-methylthiophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 20 4-[7-(4-cyanophenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 4-[7-(4-trifluoromethylphenyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
- 2-phenyl-3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-
25 ene;
- 2-(4-fluorophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
- 2-(4-chlorophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
- 30 2-(4-methylphenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
- 2-(4-methoxyphenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;
- 2-(4-methylthiophenyl)-3-[4-(methylsulfonyl)
35 phenyl]spiro[4.4]non-2-ene;
- 2-(4-cyanophenyl)-3-[4-(methylsulfonyl)phenyl]
spiro[4.4]non-2-ene;

2-(4-trifluoromethylphenyl)-3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-ene;
4-(3-phenylspiro[4.4]non-2-en-2-yl)benzenesulfonamide;
4-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]
5 benzenesulfonamide;
4-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
10 4-[3-(4-methoxyphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(4-methylthiophenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(4-cyanophenyl)spiro[4.4]non-2-en-2-yl]
15 benzenesulfonamide;
4-[3-(4-trifluoromethylphenyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
5-(3-methyl-4-fluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
20 5-(3-trifluoromethyl-4-fluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-chlorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-trifluoromethyl-4-chlorophenyl)-
25 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-methyl-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-trifluoromethyl-4-methoxyphenyl)-
30 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-fluoro-4-methoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3-chloro-4-methoxyphenyl)-
35 6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,4-dimethoxyphenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;

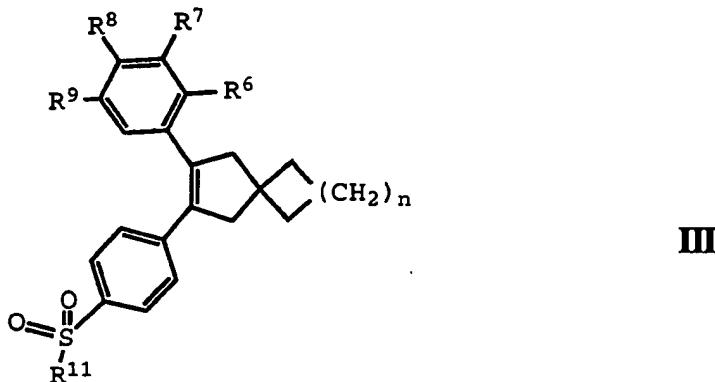
- 5-(3-chloro-4-fluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(4-chloro-3-fluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
- 5 5-(3,4-difluorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
5-(3,4-dichlorophenyl)-
6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene;
4-[6-(3-trifluoromethyl-4-fluorophenyl)spiro[2.4]hept-
10 5-en-5-yl]benzenesulfonamide;
- 4-[6-(3-trifluoromethyl-4-chlorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3-methyl-4-fluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 15 4-[6-(3-methyl-4-chlorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(4-methoxy-2,3,5,6-tetrafluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3-fluoro-4-methoxyphenyl)spiro[2.4]hept-
20 5-en-5-yl]benzenesulfonamide;
4-[6-(3-trifluoromethyl-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(3-methyl-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 25 4-[6-(3-chloro-4-methoxyphenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
4-[6-(4-methoxy-2,3,5,6-tetrafluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(3,4-dimethoxyphenyl)spiro[2.4]hept-
30 5-en-5-yl]benzenesulfonamide;
4-[6-(3-chloro-4-fluorophenyl)spiro[2.4]hept-
5-en-5-yl]benzenesulfonamide;
- 4-[6-(4-chloro-3-fluorophenyl)spiro[2.4]hept-
35 5-en-5-yl]benzenesulfonamide; and
4-[6-(3,4-dichlorophenyl)spiro[2.4]hept-

5-en-5-yl]benzenesulfonamide.

8. Compound of Claim 7 which is 5-(3,5-dichloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-ene, or a pharmaceutically-acceptable salt thereof.

9. Compound of Claim 7 which is 4-[6-(3-chloro-4-methoxyphenyl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide, or a pharmaceutically-acceptable salt thereof.

10. A compound of Formula III



15

wherein n is a number selected from 0, 1 and 2;
 wherein R⁶ is selected from hydrido and halo;
 wherein R⁷ is selected from hydrido and halo;
 20 wherein R⁸ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower haloalkyl, lower haloalkoxy, and hydroxyl;
 wherein R⁹ is selected from hydrido, halo, and lower alkyl; or wherein R⁸ and R⁹ together form methylenedioxy; and
 25 wherein R¹¹ is selected from lower alkyl and amino;
 or a pharmaceutically-acceptable salt thereof.

11. The compound of Claim 10 wherein R⁶ is selected from hydrido, fluoro, chloro, bromo, and iodo; wherein R⁷ is selected from hydrido, fluoro, chloro, bromo, and iodo; wherein R⁸ is selected from hydrido, 5 fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, 10 heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, and trifluoromethoxy; wherein R⁹ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, 15 tert-butyl, and isobutyl; or where R⁸ and R⁹ together form methylenedioxy; and wherein R¹¹ is methyl or amino; and or a pharmaceutically-acceptable salt thereof.

20 12. Compound of Claim 11 selected from compounds, and their pharmaceutically-acceptable salts, of the group consisting of

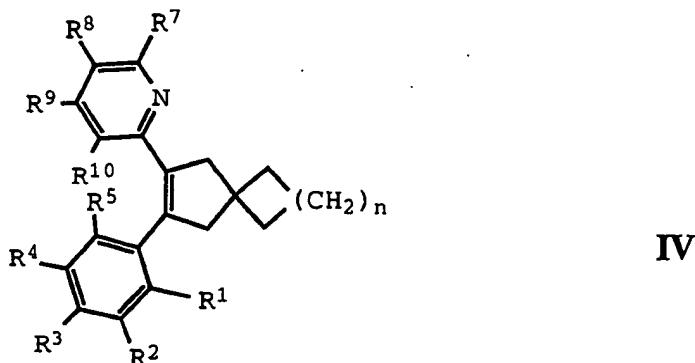
25 5-(3-chloro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
4-[6-(3-chloro-4-methoxyphenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;
30 5-(3-fluoro-4-methoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
4-[6-(3-fluoro-4-methoxyphenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;
35 5-(3,4-difluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
5-[6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-en-5-yl]-1,3-benzodioxole;
4-[6-(3,4-difluorophenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;

- 2,6-dichloro-4-[6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-en-5-
yl]phenol
- 5-(4-trifluoromethoxyphenyl)-6-[4-
5 (methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 5-(4-methoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 5-(3-bromo-4-methoxyphenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 10 4-[6-(4-methoxyphenyl)spiro[2,4]hept-5-en-5-
yl]benzenesulfonamide;
- 4-[6-(3-bromo-4-methoxyphenyl)spiro[2,4]hept-5-en-5-
yl]benzenesulfonamide;
- 5-(4-trifluoromethylphenyl)-6-[4-
15 (methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 5-(3,5-dichloro-4-methoxy-phenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 4-[6-(4-trifluoromethoxyphenyl)spiro[2,4]hept-5-en-5-
yl]benzenesulfonamide;
- 20 5-(3-chloro-4-fluorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 5-(2,4-difluorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 5-(2,4-dichlorophenyl)-6-[4-
25 (methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 4-[6-(4-trifluoromethylphenyl)spiro[2,4]hept-5-en-5-
yl]benzenesulfonamide;
- 4-[6-(3-chloro-4-fluorophenyl)spiro[2,4]hept-5-en-5-
yl]benzenesulfonamide;
- 30 5-(3,4-dichlorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 5-(4-chlorophenyl)-6-[4-
(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
- 4-[6-(3,4-dichlorophenyl)spiro[2,4]hept-5-en-5-
35 yl]benzenesulfonamide;
- 4-[6-(4-chlorophenyl)spiro[2,4]hept-5-en-5-
yl]benzenesulfonamide;

- 5-(3-chloro-4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
5-(3,4-dimethylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
5 5-(4-methylphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
5-(3-methyl-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
10 5-(3-chloro-4-trifluoromethoxyphenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
4-[6-(3,5-dichloro-4-methoxyphenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;
15 4-[6-(3-methyl-4-trifluoromethoxyphenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;
4-[6-(3-chloro-4-trifluoromethoxyphenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;
20 5-(4-fluorophenyl)-6-[4-(methylsulfonyl)phenyl]spiro[2,4]hept-5-ene;
4-[6-(4-fluorophenyl)spiro[2,4]hept-5-en-5-yl]benzenesulfonamide;
6-(4-fluorophenyl)-7-[4-(methylsulfonyl)phenyl]spiro[3,4]oct-5-ene;
25 4-[7-(4-fluorophenyl)spiro[3,4]oct-6-en-6-yl]benzenesulfonamide; and
2-(4-fluorophenyl)-3-[4-(methylsulfonyl)phenyl]spiro[4,4]non-5-ene.

30

13. A compound of Formula IV



wherein n is a number selected from 0, 1, 2 and 3; and

- 5 wherein each of R¹ through R⁵ and R⁷ through R¹⁰ is independently selected from hydrido, halo, alkyl, alkoxy, alkylthio, alkylamino, cyano, haloalkyl, haloalkoxy, hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto, alkylsulfonyl, haloalkylsulfonyl and aminosulfonyl; or a pharmaceutically-acceptable salt thereof.

14. Compound of Claim 13 wherein n is a number selected from 0, 1 and 2; wherein each of R¹, R², R⁴, R⁵, R⁷, R⁹ and R¹⁰ is independently selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, cyano, lower haloalkyl, lower haloalkoxy, lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and mercapto; and wherein R³ is selected from lower alkylsulfonyl and aminosulfonyl and R⁸ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower alkylamino, lower haloalkoxy, lower hydroxyalkyl, mercapto, hydroxyl, lower alkoxyalkyl, cyano and lower haloalkyl; or wherein further R⁸ and R⁹ together form methylenedioxy; or wherein further, R³ is selected from hydrido, halo, lower alkyl, lower alkoxy, lower alkylthio, lower alkylamino, lower haloalkoxy, lower hydroxyalkyl, hydroxyl, mercapto, lower alkoxyalkyl, cyano and lower haloalkyl, and R⁸ is selected from lower alkylsulfonyl and aminosulfonyl; or

wherein further R³ and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

15. Compound of Claim 14 wherein each of R¹,
- 5 R², R⁴, R⁵, R⁷, R⁹ and R¹⁰ is hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl,
- 10 chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, methylamino, N,N-dimethylamino,
- 15 trifluoromethoxy, hydroxymethyl, methoxymethyl and ethoxymethyl; and wherein R³ is methylsulfonyl or aminosulfonyl, and R⁸ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy,
- 20 ethoxy, propoxy, butoxy, trifluoromethoxy, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl,
- 25 difluoroethyl, difluoropropyl, dichloroethyl and dichloropropyl; or wherein further R⁸ and R⁹ together form methylenedioxy; or wherein further, R³ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl,
- 30 isobutyl, methoxy, ethoxy, propoxy, butoxy, trifluoromethoxy, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl,
- 35 difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl and dichloropropyl, and R⁸ is methylsulfonyl or

aminosulfonyl; or wherein further R³ and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

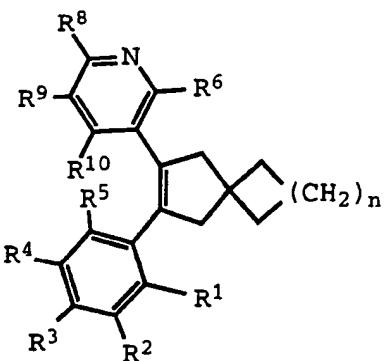
5 16. Compound of Claim 15 selected from compounds, and their pharmaceutically-acceptable salts, of the group consisting of

- 10 2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
- 15 5-fluoro-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
- 20 5-chloro-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
- 25 5-methyl-2-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
- 30 4-[6-(pyridin-2-yl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;
- 35 4-[6-(5-fluoropyridin-2-yl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;
- 40 4-[6-(5-chloropyridin-2-yl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;
- 45 4-[6-(5-methylpyridin-2-yl)spiro[2.4]hept-5-en-5-yl]benzenesulfonamide;
- 50 2-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-yl]pyridine;
- 55 5-fluoro-2-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-yl]pyridine;
- 60 5-chloro-2-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-yl]pyridine;
- 65 5-methyl-2-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-yl]pyridine;
- 70 4-[7-(pyridin-2-yl)spiro[3.4]oct-6-en-6-yl]benzenesulfonamide;
- 75 4-[7-(5-fluoropyridin-2-yl)spiro[3.4]oct-6-en-6-yl]benzenesulfonamide;
- 80 4-[7-(5-chloropyridin-2-yl)spiro[3.4]oct-6-en-6-yl]benzenesulfonamide;

benzenesulfonamide;
4-[7-(5-methylpyridin-2-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-en-2-
5 yl]pyridine;
5-fluoro-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-en-2-yl]pyridine;
5-chloro-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-en-2-yl]pyridine;
10 5-methyl-2-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-en-2-yl]pyridine;
4-[3-(pyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(5-fluoropyridin-2-yl)spiro[4.4]non-2-en-2-yl]
15 benzenesulfonamide;
4-[3-(5-chloropyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
4-[3-(5-methylpyridin-2-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;
20 2-(6-phenylspiro[2.4]hept-5-en-yl)-5-(methylsulfonyl)
pyridine;
2-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-yl]-5-
(methylsulfonyl)pyridine;
2-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-yl]-5-
25 (methylsulfonyl)pyridine;
2-[6-(4-methylphenyl)spiro[2.4]hept-5-en-yl]-5-
(methylsulfonyl)pyridine;
2-(6-phenylspiro[2.4]hept-5-en-5-yl)-5-
pyridinesulfonamide;
30 2-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-5-
pyridinesulfonamide;
2-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-5-
pyridinesulfonamide;
2-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-5-
35 pyridinesulfonamide;
2-(7-phenylspiro[3.4]oct-6-en-6-yl)-5-(methylsulfonyl)
pyridine;

- 2-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
- 2-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
- 5 2-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-5-(methylsulfonyl)pyridine;
- 2-(7-phenylspiro[3.4]oct-6-en-6-yl)-5-pyridinesulfonamide;
- 2-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-5-pyridinesulfonamide;
- 10 2-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-5-pyridinesulfonamide;
- 2-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-5-pyridinesulfonamide;
- 15 2-(3-phenylspiro[4.4]non-2-en-2-yl)-5-(methylsulfonyl)pyridine;
- 2-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
- 2-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-5-
- 20 (methylsulfonyl)pyridine;
- 2-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-5-(methylsulfonyl)pyridine;
- 2-(3-phenylspiro[4.4]non-2-en-2-yl)-5-pyridinesulfonamide;
- 25 2-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide;
- 2-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-5-pyridinesulfonamide; and
- 2-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-5-
- 30 pyridinesulfonamide.

17. A compound of Formula V



V

wherein n is a number selected from 0, 1, 2 and 3;
and

- 5 wherein each of R¹ through R⁶ and R⁸ through R¹⁰ is
independently selected from hydrido, halo, alkyl,
alkoxy, alkylthio, alkylamino, cyano, haloalkyl,
haloalkoxy, hydroxyalkyl, alkoxyalkyl, hydroxyl,
mercapto, alkylsulfonyl and aminosulfonyl; or a
10 pharmaceutically-acceptable salt thereof.

18. Compound of Claim 17 wherein n is a
number selected from 0, 1 and 2; wherein each of R¹,
R², R⁴, R⁵, R⁶, R⁹ and R¹⁰ is independently selected
15 from hydrido, halo, lower alkyl, lower alkoxy, lower
alkylthio, cyano, lower haloalkyl, lower haloalkoxy,
lower hydroxyalkyl, lower alkoxyalkyl, hydroxyl and
mercapto; and wherein R³ is selected from lower
alkylsulfonyl and aminosulfonyl and R⁸ is selected from
20 hydrido, halo, lower alkyl, lower alkoxy, lower
alkylthio, lower alkylamino, lower haloalkoxy, lower
hydroxyalkyl, mercapto, hydroxyl, lower alkoxyalkyl,
cyano and lower haloalkyl; or wherein further R⁸ and R⁹
25 together form methylenedioxy; or wherein further, R³ is
selected from hydrido, halo, lower alkyl, lower alkoxy,
lower alkylthio, lower alkylamino, lower haloalkoxy,
lower hydroxyalkyl, hydroxyl, lower alkoxyalkyl, cyano
and lower haloalkyl, and R⁸ is selected from lower
alkylsulfonyl and aminosulfonyl; or wherein further R³

and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

19. Compound of Claim 18 wherein each of R¹,
- 5 R², R⁴, R⁵, R⁶, R⁹ and R¹⁰ is hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, hydroxyl, mercapto, methylthio, ethylthio, cyano, fluoromethyl, difluoromethyl, trifluoromethyl,
- 10 chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl, dichloropropyl, trifluoromethoxy, hydroxymethyl,
- 15 methoxymethyl and ethoxymethyl; and wherein R³ is methylsulfonyl or aminosulfonyl, and R⁸ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl, ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy,
- 20 trifluoromethoxy, hydroxyl, methylthio, ethylthio, methylamino, N,N-dimethylamino, cyano, mercapto, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, pentafluoroethyl, heptafluoropropyl,
- 25 difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl and dichloropropyl; or wherein further R⁸ and R⁹ together form methylenedioxy; or wherein further, R³ is selected from hydrido, fluoro, chloro, bromo, iodo, methyl,
- 30 ethyl, n-propyl, isopropyl, butyl, tert-butyl, isobutyl, methoxy, ethoxy, propoxy, butoxy, trifluoromethoxy, hydroxyl, methylthio, ethylthio, cyano, mercapto, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl,
- 35 trichloromethyl, pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl and

dichloropropyl, and R⁸ is methylsulfonyl or aminosulfonyl; or wherein further R³ and R⁴ together form methylenedioxy; or a pharmaceutically-acceptable salt thereof.

5

20. Compound of Claim 19 selected from compounds, and their pharmaceutically-acceptable salts, of the group consisting of

- 10 5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
2-fluoro-5-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-yl]pyridine;
2-chloro-5-[6-[4-(methylsulfonyl)phenyl]spiro
15 [2.4]hept-5-en-5-yl]pyridine;
2-methyl-5-[6-[4-(methylsulfonyl)phenyl]
spiro[2.4]hept-5-en-5-yl]pyridine;
4-[6-(pyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
- 20 4-[6-(2-fluoropyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-(2-chloropyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
benzenesulfonamide;
4-[6-(2-methylpyridin-5-yl)spiro[2.4]hept-5-en-5-yl]
25 benzenesulfonamide;
5-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-yl]pyridine;
2-fluoro-5-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-
6-en-6-yl]pyridine;
- 30 2-chloro-5-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-
6-en-6-yl]pyridine;
2-methyl-5-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-
6-en-6-yl]pyridine;
4-[7-(pyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
35 benzenesulfonamide;
4-[7-(2-fluoropyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
4-[7-(2-chloropyridin-5-yl)spiro[3.4]oct-6-en-6-yl]

benzenesulfonamide;

4-[7-(2-methylpyridin-5-yl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;

5-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-en-2-
5
yl]pyridine;

2-fluoro-5-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-en-2-yl]pyridine;

2-chloro-5-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-en-2-yl]pyridine;

10 2-methyl-5-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-
2-en-2-yl]pyridine;

4-[3-(pyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

4-[3-(2-fluoropyridin-5-yl)spiro[4.4]non-2-en-2-yl]
15 benzenesulfonamide;

4-[3-(2-chloropyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

4-[3-(2-methylpyridin-5-yl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide;

20 5-(6-phenylspiro[2.4]hept-5-en-5-yl)-2-(methylsulfonyl)
pyridine;

5-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

5-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
25 (methylsulfonyl)pyridine;

5-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-2-
(methylsulfonyl)pyridine;

5-(6-phenylspiro[2.4]hept-5-en-5-yl)-2-
pyridinesulfonamide;

30 5-[6-(4-fluorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
pyridinesulfonamide;

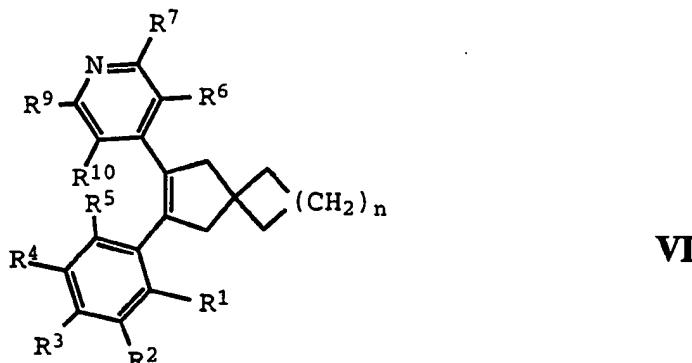
5-[6-(4-chlorophenyl)spiro[2.4]hept-5-en-5-yl]-2-
pyridinesulfonamide;

5-[6-(4-methylphenyl)spiro[2.4]hept-5-en-5-yl]-2-
35 pyridinesulfonamide;

5-(7-phenylspiro[3.4]oct-6-en-6-yl)-2-(methylsulfonyl)
pyridine;

- 5-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-2-(methylsulfonyl)pyridine;
- 5-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-2-(methylsulfonyl)pyridine;
- 5 5-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-2-(methylsulfonyl)pyridine;
- 5-(7-phenylspiro[3.4]oct-6-en-6-yl)-2-pyridinesulfonamide;
- 5-[7-(4-fluorophenyl)spiro[3.4]oct-6-en-6-yl]-2-10 pyridinesulfonamide;
- 5-[7-(4-chlorophenyl)spiro[3.4]oct-6-en-6-yl]-2-pyridinesulfonamide;
- 5-[7-(4-methylphenyl)spiro[3.4]oct-6-en-6-yl]-2-pyridinesulfonamide;
- 15 5-(3-phenylspiro[4.4]non-2-en-2-yl)-2-(methylsulfonyl)pyridine;
- 5-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-2-20 (methylsulfonyl)pyridine;
- 5-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-2-(methylsulfonyl)pyridine;
- 5-(3-phenylspiro[4.4]non-2-en-2-yl)-2-pyridinesulfonamide;
- 25 5-[3-(4-fluorophenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide;
- 5-[3-(4-chlorophenyl)spiro[4.4]non-2-en-2-yl]-2-pyridinesulfonamide; and
- 5-[3-(4-methylphenyl)spiro[4.4]non-2-en-2-yl]-2-30 pyridinesulfonamide.

21. A compound of Formula VI



wherein n is a number selected from 0, 1, 2 and 3;
and

5 wherein each of R¹ through R⁷, R⁹ and R¹⁰ is
independently selected from hydrido, halo, alkyl,
alkoxy, alkylthio, cyano, haloalkyl, haloalkoxy,
hydroxyalkyl, alkoxyalkyl, hydroxyl, mercapto,
alkylsulfonyl and aminosulfonyl; or a pharmaceutically-
10 acceptable salt thereof.

22. Compound of Claim 21 wherein n is a
number selected from 0, 1 and 2; wherein each of R¹,
R², R⁴ through R⁷, R⁹ and R¹⁰ is independently selected
15 from hydrido, halo, lower alkyl, lower alkoxy, lower
alkylthio, lower haloalkoxy, lower hydroxyalkyl,
hydroxyl, lower alkoxyalkyl, mercapto, cyano and lower
haloalkyl; and wherein R³ is selected from lower
alkylsulfonyl and aminosulfonyl; or a pharmaceutically-
20 acceptable salt thereof.

23. Compound of Claim 22 wherein each of R¹,
R², R⁴ through R⁷, R⁹ and R¹⁰ is independently selected
from hydrido, fluoro, chloro, bromo, iodo, methyl,
25 ethyl, n-propyl, isopropyl, butyl, tert-butyl,
isobutyl, methoxy, ethoxy, propoxy, butoxy,
trifluoromethoxy, methylthio, ethylthio, cyano,
hydroxyl, mercapto, fluoromethyl, difluoromethyl,
trifluoromethyl, chloromethyl, dichloromethyl,
30 trichloromethyl, pentafluoroethyl, heptafluoropropyl,

difluorochloromethyl, dichlorofluoromethyl,
difluoroethyl, difluoropropyl, dichloroethyl,
dichloropropyl, hydroxymethyl, methoxymethyl and
ethoxymethyl; and wherein R³ is methylsulfonyl or
5 aminosulfonyl; or a pharmaceutically-acceptable salt
thereof.

24. Compound of Claim 23 selected from
compounds, and their pharmaceutically-acceptable salts,
10 of the group consisting of

4-[6-[4-(methylsulfonyl)phenyl]spiro[2.4]hept-5-en-5-
yl]pyridine;
4-[6-(4-pyridinyl)spiro[2.4]hept-5-en-5-yl]
15 benzenesulfonamide;
4-[7-[4-(methylsulfonyl)phenyl]spiro[3.4]oct-6-en-6-
yl]pyridine;
4-[7-(4-pyridinyl)spiro[3.4]oct-6-en-6-yl]
benzenesulfonamide;
20 4-[3-[4-(methylsulfonyl)phenyl]spiro[4.4]non-2-en-2-yl]
pyridine; and
4-[3-(4-pyridinyl)spiro[4.4]non-2-en-2-yl]
benzenesulfonamide.

25 25. A pharmaceutical composition comprising a
therapeutically-effective amount of a compound, said
compound selected from a family of compounds of Claim
1; or a pharmaceutically-acceptable salt thereof.

30 26. A pharmaceutical composition comprising a
therapeutically-effective amount of a compound, said
compound selected from a family of compounds of Claim
4; or a pharmaceutically-acceptable salt thereof.

35 27. A pharmaceutical composition comprising a
therapeutically-effective amount of a compound, said
compound selected from a family of compounds of Claim
5; or a pharmaceutically-acceptable salt thereof.

28. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a family of compounds of Claim
5 6; or a pharmaceutically-acceptable salt thereof.

29. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a family of compounds of Claim
10 7; or a pharmaceutically-acceptable salt thereof.

30. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a compound of Claim 8; or a
15 pharmaceutically-acceptable salt thereof.

31. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a compound of Claim 9; or a
20 pharmaceutically-acceptable salt thereof.

32. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a family of compounds of Claim
25 10; or a pharmaceutically-acceptable salt thereof.

33. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a family of compounds of Claim
30 13; or a pharmaceutically-acceptable salt thereof.

34. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a family of compounds of Claim
35 17; or a pharmaceutically-acceptable salt thereof.

35. A pharmaceutical composition comprising a therapeutically-effective amount of a compound, said compound selected from a family of compounds of Claim 21; or a pharmaceutically-acceptable salt thereof.

5

36. A method of treating inflammation or an inflammation-associated disorder in a subject, said method comprising administering to the subject having or susceptible to such inflammation or inflammation-associated disorder, a therapeutically-effective amount of a compound of Claim 1; or a pharmaceutically-acceptable salt thereof.

15 37. A method of treating inflammation or an inflammation-associated disorder in a subject, said method comprising administering to the subject having or susceptible to such inflammation or inflammation-associated disorder, a therapeutically-effective amount of a compound of Claim 4; or a pharmaceutically-acceptable salt thereof.

20 38. A method of treating inflammation or an inflammation-associated disorder in a subject, said method comprising administering to the subject having or susceptible to such inflammation or inflammation-associated disorder, a therapeutically-effective amount of a compound of Claim 5; or a pharmaceutically-acceptable salt thereof.

30 39. A method of treating inflammation or an inflammation-associated disorder in a subject, said method comprising administering to the subject having or susceptible to such inflammation or inflammation-associated disorder, a therapeutically-effective amount of a compound of Claim 6; or a pharmaceutically-acceptable salt thereof.

35

40. A method of treating inflammation or an
inflammation-associated disorder in a subject, said
method comprising administering to the subject having
or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount
5 of a compound of Claim 7; or a pharmaceutically-
acceptable salt thereof.

41. A method of treating inflammation or an
10 inflammation-associated disorder in a subject, said
method comprising administering to the subject having
or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount
of a compound of Claim 8; or a pharmaceutically-
15 acceptable salt thereof.

42. A method of treating inflammation or an
inflammation-associated disorder in a subject, said
method comprising administering to the subject having
20 or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount
of a compound of Claim 9; or a pharmaceutically-
acceptable salt thereof.

25 43. A method of treating inflammation or an
inflammation-associated disorder in a subject, said
method comprising administering to the subject having
or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount
30 of a compound of Claim 10; or a pharmaceutically-
acceptable salt thereof.

44. A method of treating inflammation or an
inflammation-associated disorder in a subject, said
35 method comprising administering to the subject having
or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount

of a compound of Claim 13; or a pharmaceutically-acceptable salt thereof.

45. A method of treating inflammation or an
5 inflammation-associated disorder in a subject, said
method comprising administering to the subject having
or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount
of a compound of Claim 17; or a pharmaceutically-
10 acceptable salt thereof.

46. A method of treating inflammation or an
inflammation-associated disorder in a subject, said
method comprising administering to the subject having
15 or susceptible to such inflammation or inflammation-
associated disorder, a therapeutically-effective amount
of a compound of Claim 21; or a pharmaceutically-
acceptable salt thereof.

20 47. The method of Claim 36 for use in
treatment of inflammation.

25 48. The method of Claim 36 for use in
treatment of an inflammation-associated disorder.

49. The method of Claim 48 wherein the
inflammation-associated disorder is arthritis.

30 50. The method of Claim 48 wherein the
inflammation-associated disorder is pain.

51. The method of Claim 48 wherein the
inflammation-associated disorder is fever.

INTERNATIONAL SEARCH REPORT

Int'l. Application No
PCT/US 95/01385

A. CLASSIFICATION OF SUBJECT MATTER					
IPC 6	C07C317/14	C07C317/22	C07C311/16	C07C311/29	C07C323/65
	C07D213/56	C07D213/52	C07D213/61	C07D213/70	A61K31/18
	A61K31/10	A61K31/44			

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C07C C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>GENERAL PHARMACOLOGY, vol. 24, no. 1, January 1993 OXFORD, GB, pages 105-110, N. FUTAKI, ET AL.: 'NS-398, a novel non-steroidal anti-inflammatory drug with potent analgesic and antipyretic effects, which causes minimal stomach lesions' see the whole document</p> <p>---</p> <p>-/-</p>	1,25,36

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 1995	- 7.05.95

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English, R

INTERNATIONAL SEARCH REPORT

Inte	nal Application No
PCT/US 95/01385	

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JOURNAL OF BIOLOGICAL CHEMISTRY, vol. 268,no. 9, 25 March 1993 BALTIMORE, MD, US, pages 6610-6614, E.A. MEADE, ET AL.: 'Differential inhibition of prostaglandin endoperoxide synthetase (cyclooxygenase) isoenzymes by aspirin and other non-steroidal anti-inflammatory drugs' see the whole document ----	1,25,36
P,A	US,A,5 344 991 (D.B. REITZ, ET AL.) 6 September 1994 see the whole document -----	1,25,36

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US95/01385

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
Although claims 36-51 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound.
2. Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Appl. Application No
PCT/US 95/01385

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-5344991	06-09-94	WO-A- 9511883	04-05-95